POWER

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The Electrical Bugaboo

A SPECIAL collection was being taken to raise money for coal to heat the church. When the plate reached a usually liberal contributor he winked knowingly at the collector and allowed him to pass on.

The priest, who had seen the by-play, expressed his disappointment to the parishioner after the service. "Tush Father," said he, with the same sly wink, "what need have you of coal? Shure you're heating the church now by steam."

The same failure to see around the first corner seems to possess a lot of people who are exercised over the growth of the electrical industry. All of our industries are to be run on boughten current and the poor power plant relegated to limbo.

We are going to heat by steam. What do we need of coal?

True, electricity can be made by water power, and the ease with which it can be transmitted makes practicable the development of water powers that, if their power had to be utilized on the spot, would long continue to run to waste.

But by far the greater part of the electricity that is used is produced by the burning of fuel; even the hydro-electric plant has usually to have its steam plant as a stand-by.

No other agency has contributed so much to the increased use of artificially produced power as has electricity. The electric light alone calls for thousands upon thousands of horsepower, the street railways hundreds of thousands more. The motor is so handy that it finds myriads of uses for work formerly done by muscular effort.

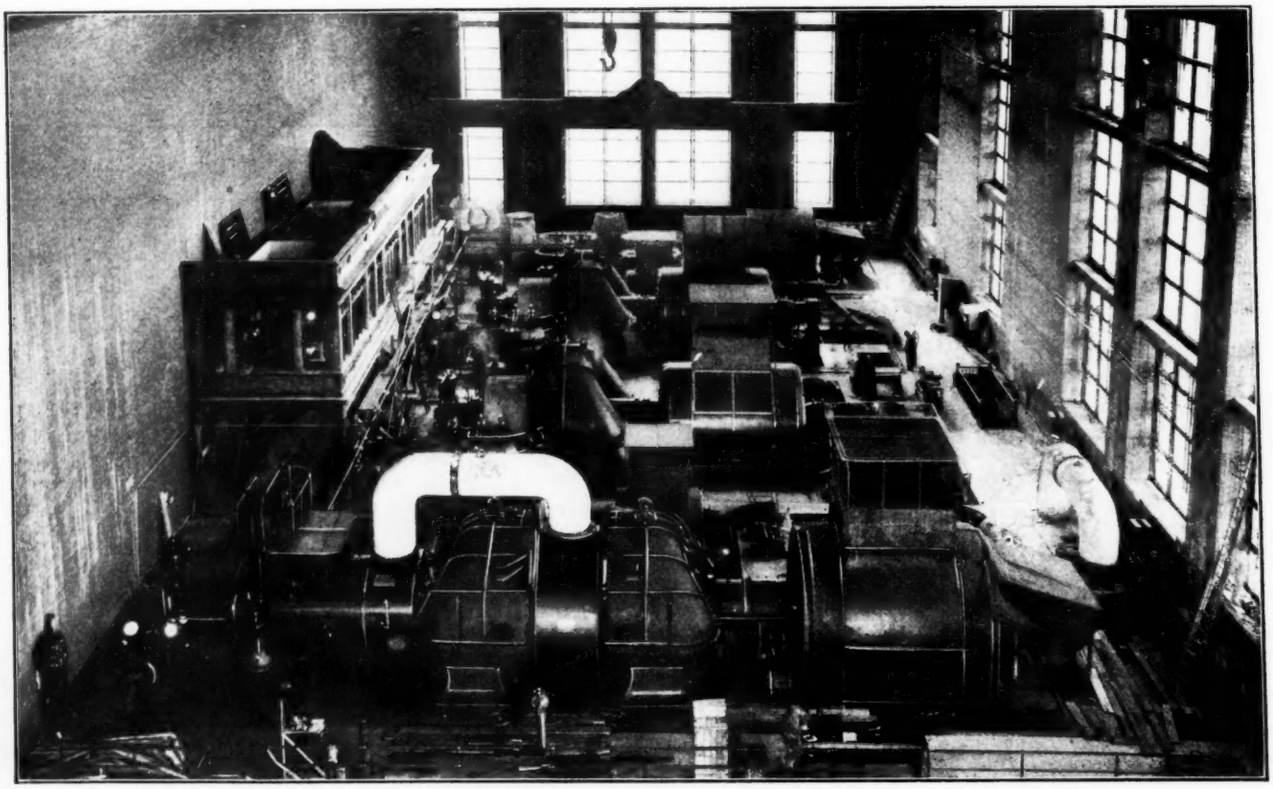
And for every kilowatt of electricity used something like one and a half horsepower must be developed in some kind of a prime mover.

The growth of electricity has involved the installation of more power-plant machinery, the development of bigger and more efficient power-plant apparatus and offered greater opportunities to the power-plant engineer who kept abreast of the times than any other factor in the last half century.

The more electricity that there is used the more power-plants will be installed; and notwithstanding the movement in the direction of concentration and centralization there were by the last census 11,000 more stationary engineers and 33,000 more firemen than by that of ten years ago.

Let not your hearts be troubled, but put your heads to work to keep up with the new developments and avail yourselves of the new opportunities.

F. R. Low



Turbines at the Hell Gate Station

THE FOUR main units of the new Hell Gate power station of the United Electric Light and Power Company, New York, consist of two 40,000-kw. Westinghouse and two 35,000-kw. General Electric turbines. The former will be described first.

In spite of the apparent advantage of the cross-compound turbine, the Westinghouse tandem-compound machine was chosen because of its satisfactory record.

Comparing the two types, it will be recalled that the tandem unit contains but one generator, which is subject to being put out of commission entirely when either the high-pressure or the low-pressure turbine is unavailable. The cross-compound unit, however, may still carry load on one turbine when the other one is disabled. Problems of expansion are much more simple in a cross-compound unit, where each turbine is connected by a flexible coupling to the generator, than in a tandem unit, where the rotors are rigidly connected to each other, and flexibly to the generator.

The tandem unit is preferable from the standpoint of switchboard operation, as there is only one generator to handle. The tandem unit costs less than a cross compound. The first reaction tandem unit was built by request of purchaser; it was followed by three others, and the analyses of operating records to date have thoroughly demonstrated the reliability of the tandem reaction turbine, to which may be added the advantage of handling a single generator, in electrical operation and less space for control equipment, rheostats, blowers, conduit and less attention of the operators.

Steam is supplied to the turbines at 250 lb. gage and 200 deg. superheat, giving a total admission temperature of 606 deg. F. The speed is 1,200 r.p.m.; the most economical load is 28,000 kw., and the maximum load is 40,000 kilowatts.

The steam consumption of the Westinghouse units, with exhaust at one inch of mercury absolute, is as follows:

Kw. Output	Pounds Steam per Kw.-Hr.
15,000	11.15
20,000	10.75
28,000	10.40
35,000	10.65
40,000	10.90

Each tandem unit comprises a single-flow, high-pressure turbine at one end, with a combined single-divided-flow low-pressure turbine in the middle. The generator is connected to the latter element, with the usual flexible pin and bushing coupling. The turbine rotors are rigidly attached by means of a bolted coupling whose flanges are forged solid with the shafts. This coupling carries the thrust of the low-pressure element, as well as half the weight of the high-pressure rotor, since the

THE turbine room at Hell Gate at present contains four main units and two house turbines. These are divided into two groups, each consisting of one 40,000-kw. 60-cycle Westinghouse tandem-compound turbo-generator, one 35,000-kw. 25-cycle General Electric single-cylinder turbo-generator and a 2,000-kw. 60-cycle Westinghouse house turbine. The 25-cycle main units generate at 11,400 volts, and the 60-cycle at 13,200 volts, the house turbines feeding the auxiliary bus at 2,300 volts. This article describes the main units.

high-pressure element contains only one bearing, which is placed at the governor end. Two bearings are provided for the generator and two for the low-pressure turbine. The low-pressure cylinder is rigidly supported at the end toward the generator. The remainder of the turbine elements are free to expand toward the governor, so that the end bearing moves approximately ½ in. in expanding away from the generator, from cold to running temperature.

With 28,000 kw. on the machine, the low-pressure element carries twice as much load as the high-pressure. This proportioning is the result of carrying out the main steam expansion in such a way that blade lengths and other demands conducive to the highest efficiency may be used, and still permit other physical dimensions of turbine structure, such as the distance between the bearings, to be proportioned so as to give a maximum degree of strength and reliability.

The following table gives the pressure in pounds absolute, steam quality in per cent moisture or degrees superheat, and specific volume at various stages throughout the turbine; at 28,000-kw. load:

	Pressure Lbs. Abs.	Quality	Specific Volume
High-pressure turbine inlet	250	200	2.46
Inlet to low-pressure stage of H. P. turbine	127	122	4.23
Inlet to low-pressure turbine	50	30.5	8.93
Inlet to low-pressure stage of L. P. turbine	8.3	5.6%	43.2
At primary heater connection	4.1	8.0%	81.6
At L. P. turbine exhaust	.5	14.0%	565

Blades are of the standard type; they may easily be removed, and have their area much reduced at the ends, so that they will wear easily in case rubbing occurs without losing much metal in the turbine. The blades vary in length from 4 in. up to 18 in. and provision is made against vibration by the regular method of lashing with wire. The largest blades contain three wires passing through them. The outer wire has a cross-section resembling a "comma," the inner wires are round, and all are soldered to the blades.

The clearances from the ends of the blades to the interior of the turbine vary from .05 to .80 in. Both of the turbine elements are arranged to have a small thrust toward the generator when under load. Kingsbury thrust bearings are provided at the governor end, the bearing which takes the thrust in the direction of the generator being made slightly larger.

Temporary Bearing Used in Aligning Turbine

The problem of alignment is met by placing a temporary bearing in the coupling end of the high-pressure rotor, which rests in the bore where the lower section of the oil baffle is normally placed. The coupling is disconnected and the high-pressure shaft is then aligned for proper clearances in the usual manner by adjusting the temporary and the permanent bearing. The low-pressure cylinder also has its clearances set in the usual manner, and the couplings are then lined up central and parallel by shifting the high-pressure cylinder on its supports. When satisfactory alignment has been reached, the coupling flanges are bolted together, and the temporary bearings removed from the high-pressure element. The governor end of this cylinder is lowered slightly by reducing the shims under the support, in order to compensate for increased expansion when running temperature is reached. The coupling end of the high-pressure cylinder is supported directly on the low-pressure cylinder, to avoid unequal expansions at this point. Shims are placed between at "S," Fig. 2. The generator is aligned at the flexible coupling of the low-pressure turbine in the usual manner.

High-Pressure Cylinder Is Single-Flow and Low-Pressure Is Single-Double-Flow

The high-pressure rotor contains 45 rows of stationary and 45 rows of revolving blades, the shortest of which are 4 in. long and ¾ in. wide. This is a straight reaction turbine, and would have smaller losses

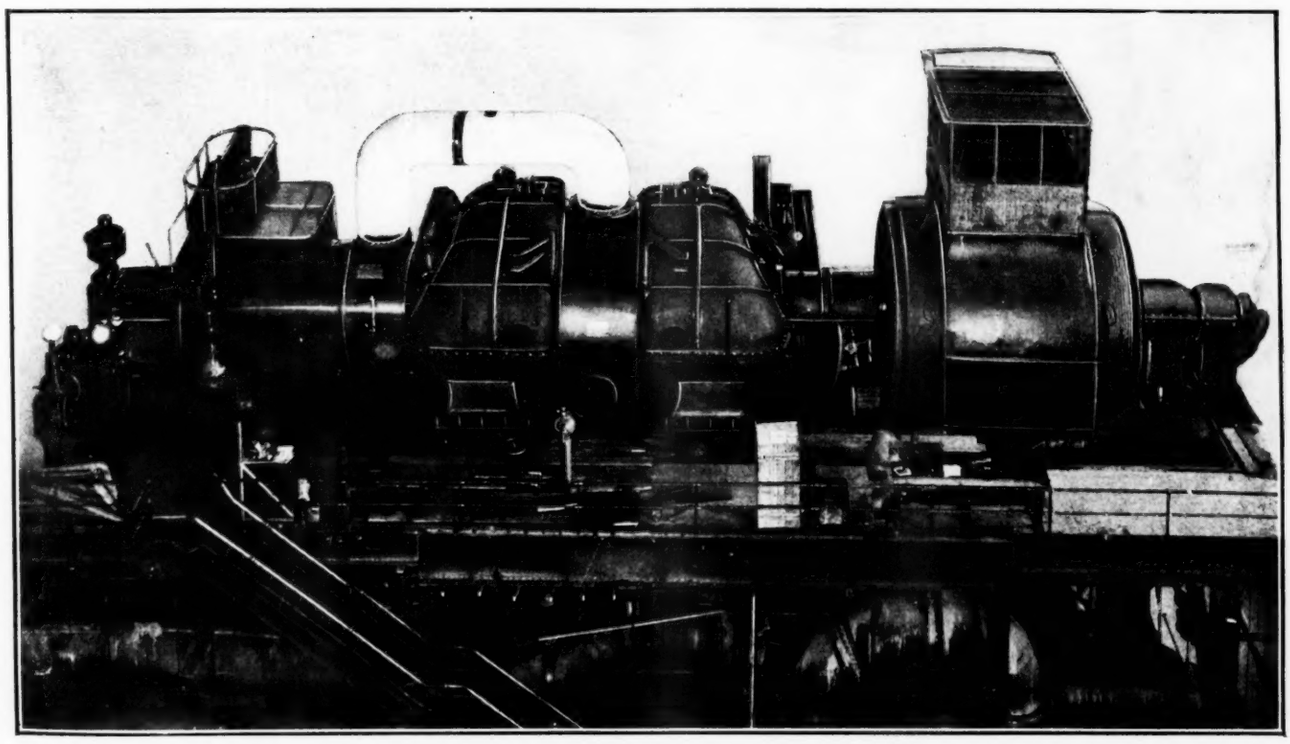


FIG. 1. 40,000-KW. WESTINGHOUSE TANDEM UNIT

and higher net efficiency than a two-stage velocity impulse wheel. The rotor and cylinder are of steel.

A single-double-flow turbine comprises the low-pressure element. Steam travels in one direction for a short distance and then divides, so that part of the steam expands over one end of the rotor, and the remainder travels through the space between the inner and outer cylinder walls, expanding over the other end. The low-pressure rotor contains fifteen rows of stationary and fifteen rows of revolving blades in the single-flow portion, while each of the divided flow portions contains eight rows of stationary and eight rows of revolving blades. The turbine casing is drilled over the nineteenth row of revolving blades at "d" in each low-pressure end, so that steam at 4.1 lb. abs. can be extracted for closed heater purposes. Steam at 8.3 lb. abs. is available for bleeding from the fifteenth to the sixteenth row, but is not employed in this station. These pressures occur when the load is exactly 28,000 kw. The rotor is of steel and the cylinder of cast iron.

Valve and Governor Adjustments

The primary valve is bolted to the combined automatic trip and throttle valve, and both are carried on springs in the usual manner and piped rigidly to the turbine, so that they move freely in accordance with the expansion of the turbine. Pipe connection to the header is sufficiently flexible to allow this movement without undue stress. The secondary and tertiary valves are mounted rigidly on the turbine cylinder. These three valves are so connected mechanically that the secondary begins to open as soon as the primary valve has reached a pressure of 250 lb. abs. at the inlet to the turbine. The secondary valve supplies steam to the second barrel of the rotor, and the tertiary to the third barrel, or group of blades. At 28,000 kw. the pressures are: first barrel, 250 lb. abs., second 185 lb. abs. and third 152 lb. abs. When the secondary reaches a pressure of 250 lb. abs. the tertiary valve begins to open. The primary valve is wide open at 28,000 kw., the secondary at 35,000 kw., and the tertiary at 40,000 kw. or slightly more.

The usual governor regulation is supplied, there being a total of 4 per cent difference in speed from the no-load position to full opening of valves. Two per cent is required from no load to 28,000 kw., and 1 per cent from that point to 35,000 kw., while the remaining 1 per cent opens the valves their full amount. The synchronizing spring is capable of varying the speed 5 per cent above or below at any of these points. A

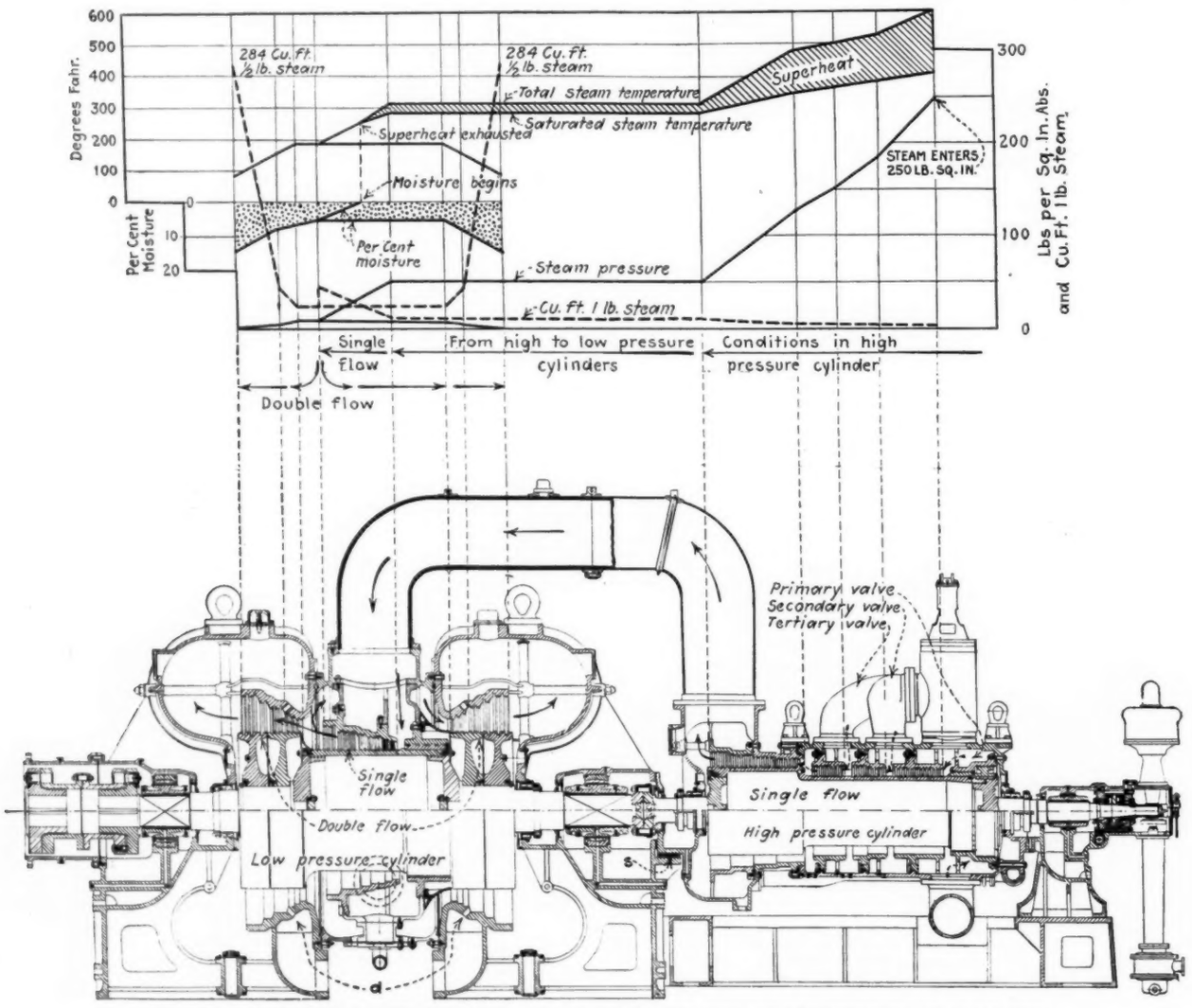


FIG. 2. 40,000-KW. WESTINGHOUSE UNIT, SHOWING STEAM CONDITIONS AT 28,000 KW.
The primary valve is admitting steam at 250 lb. sq. in., the secondary valve is just beginning to open, and the tertiary is closed.

standard emergency governor is provided which closes both the throttle and the primary inlet valve when it is tripped.

Self-Aligning Bearings and Oiling System

The oiling system contains 1,000 gal. of oil and circulates about 150 gal. per min. Usual oil pressures of 5 lb. for the bearings and 50 to 60 lb. for the governor are provided from a rotary pump geared to the turbine shaft. The oiling system contains a cooler, so arranged that the entire piping element can be lifted out for cleaning, and also a strainer box and an oil receiver. The cooler has 600 sq.ft. of surface area.

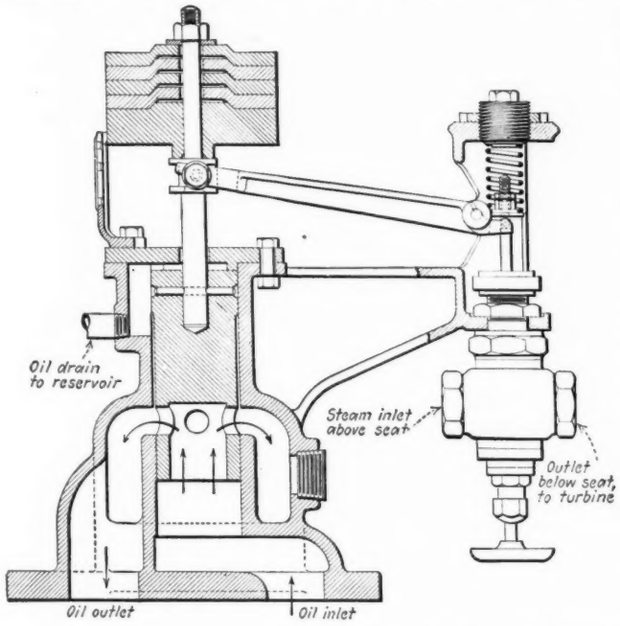


FIG. 3. OIL GOVERNOR INDICATES ACTUAL PRESSURE AND AUTOMATICALLY CUTS IN THE AUXILIARY TURBO PUMP WHEN NECESSARY

The main bearings are of the usual type, with cast-iron split shells, babbitt-lined. Each bearing is supported in a spherically bored recess so that it is free to move and align itself with changing angles of the shaft, as caused by expansion, change of load, temperature, etc.

The spherical surface of the bearing which fits this recess is formed on four bosses, bolted to the liner at the top, bottom and sides. Each spherical boss is separated from the liner by flat shims, so that the liner can be lowered by removing shims from the boss at the bottom and adding them to that on the top. Any desired change of position can similarly be accurately made, and the clearance in this spherical fit adjusted as desired.

A maximum journal speed of 95 ft. per sec. is provided for, and the bearing pressure is 105 lb. per sq.in.

Oil is admitted on the top of the shaft by a longitudinal oil groove at approximately 5 lb. per sq.in. That discharged from the governor mixes with the oil at 5 lb. pressure supplied by the pump, and passes through the cooler and then through the bearings.

Steam and Water Packing Glands

Labyrinth shaft glands are placed at either end of each rotor. These use both steam and water. Water glands are placed on the outside, preventing steam from entering the room. The steam gland is useful in making it possible to heat the rotor at a low vacuum when starting up. The high-pressure rotor contains three sections of steam labyrinths, and the low-pressure contains two sections. These are supplied with steam from a common source in the starting, but the high-pressure steam supply is shut after the turbine is in operation. A maximum pressure of 35 lb. gage is exerted on the glands under the full load conditions of the higher-pressure rotor. This leaks through the labyrinth to a drain, and then to the low-pressure element, so that this high steam pressure does not reach the water glands. No automatic regulation is necessary.

Auxiliary Turbine-Driven Rotary Oil Pump

The oil pump used is a comparatively new development, and supersedes the duplex reciprocating pump, eliminating the maintenance of reciprocating steam and oil valves.

The oil governor shown in Fig. 3 contains a vertical weighted piston, which is maintained in its position by the oil pressure underneath and which is equipped with orifices so that the leakage of the oil determines its vertical height. A scale and pointer at the top indicate the oil pressure applied. When the oil supply becomes less than desired, the oil piston lowers to a point where it opens the valve to the steam-driven auxiliary pump. The pressure of this auxiliary pump is then governed by the rise and fall of this piston, the motion being transmitted through the lever arm as shown. Weight may be placed on the top of the piston as desired for adjusting the pressure held. The shaft is fitted with a collar for operation of the valve lever arm, which allows the piston to be spun by hand to insure that there is no friction or binding. This governor can be placed where it is easily seen and will indicate to the turbine operator the exact condition of the oil supply.

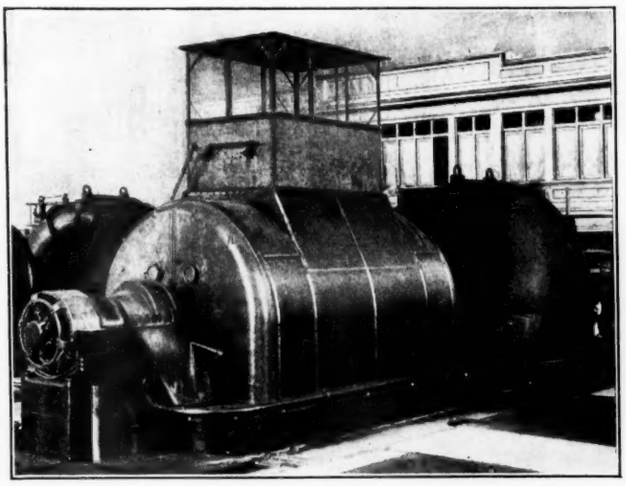


FIG. 3A. 35,000-KW. GENERAL ELECTRIC TURBO-GENERATOR UNIT

Fig. 4 shows a section of the single-stage turbine. The wheel is secured by a taper fit to the shaft, on which the worm is cut integrally. A frictionless labyrinth packing gland is supplied; the shaft contains two babbitted sleeves with a ball thrust bearing at the end opposite to the turbine. Blades are cut out of solid metal on the flanged surface of the wheel. The latter may operate at 2,000 r.p.m. or more, but the turbine

contains no governor and its speed is controlled by the torque of the oil pump. Normal speed is 1,980 r.p.m. of the turbine and 165 r.p.m. of the pump.

Fig. 5 shows a cross-section cutting across the axis of the pump itself, and Fig. 6 shows a section taken lengthwise through the pump. The rotating element is of steel and is placed in an eccentric position in respect to the two perforated guide sleeves, one of which is outside and one of which is inside this revolving element. Steel vanes in the rotor are shifted during the revolution of the pump by the perforated guides. These bushings are of cast iron and are contained in babbitt bearings. They may revolve or not, depending on the friction. Since the vanes usually produce more friction on the guides than the bearings do, the guides ordinarily revolve in the direction of rotation.

The oil pumped by the outside of the revolving member is at 5 lb. per sq.in., and a small quantity of this oil is returned through the interior and pumped to 60 lb. for use in the governor. The pump operates at 150 or 200 r.p.m.

General Electric Main Units

The two 35,000-kw. 25-cycle turbine-generator sets supplied by the General Electric Company are of the same general type as 48 machines of 25,000-kw. capacity, and larger now in successful operation in important central stations throughout the country. They emphasize the simple, compact and strong construction possible even in units of large capacity with the impulse type of turbine.

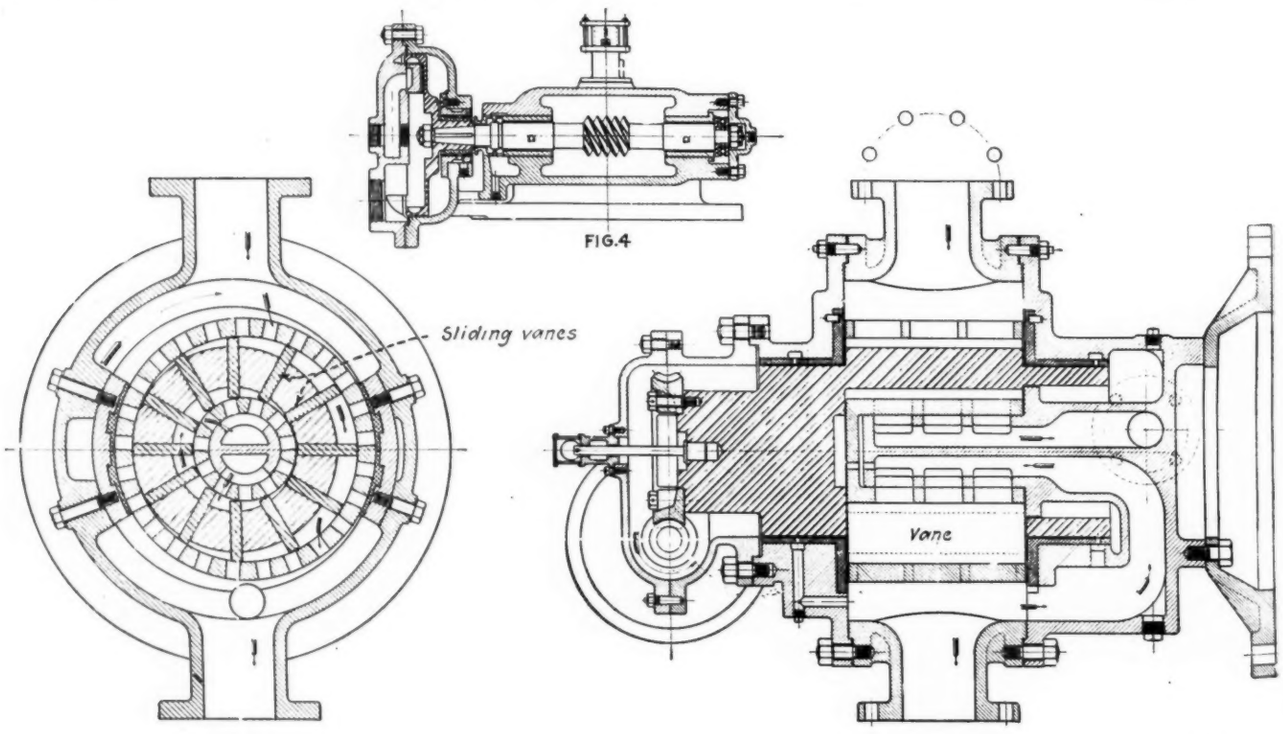
The turbines are of the single-cylinder type. That is, the complete expansion of the steam takes place in one cylinder. All parts of the turbines that are subjected to high-temperature steam are of steel or non-corrosive metal of high tensile strength. The high-pressure shells are of steel and are of the so-called clamshell type, in which the vertical joint is moved down into the low pressure, low temperature range of the turbine. In this portion of the turbine there is relatively little expansion due to temperature changes, and a tight joint between the steel and cast-iron portions of the turbine is assured.

The emergency governor is so designed that it may be tripped and all parts of the emergency mechanism may be tested out without disconnecting the generator from the line. A jet of oil through suitable mechanism performs the function of centrifugal force and causes the emergency governor to trip the latch, thus closing both throttle and control valves. The governor spring, by virtue of its design, resets at approximately 101 per cent of normal speed. The throttle valve and control valves can then be opened and load placed on the machine without re-synchronizing.

In this simple way, all parts of the emergency mechanism can be tested, the only undetermined element being the speed at which the emergency governor will trip. This is usually set at about 8 per cent above speed. However, the calibration of the emergency governor spring is of comparatively small importance, and can be checked at suitable intervals in the usual way. It is essential to be assured that when the governor does trip the connecting mechanism will function properly and promptly.

The operation of the emergency governor actuates two entirely separate sequences of mechanical action one of which closes the throttle valve and the other closes the control valves. These mechanisms are not only entirely independent one of the other, but neither is in any way connected with or dependent on the operating governor, the hydraulic cylinder, or the connecting parts.

The clearances between buckets and the stationary parts are liberal; the axial clearance varying from



FIGS. 4, 5 AND 6. SMALL TURBINE OPERATES ROTARY PUMP THROUGH WORM AND GEAR

0.140 in. to 0.500 in., and the radial clearances from 0.250 in. up to 2.000 in. These clearances are determined by mechanical design only.

The steam enters at 250 lb. per sq.in. abs. pressure and 200 deg. superheat, passes through 20 Curtis, single-row, impulse stages to an absolute pressure of about 1 in. The guaranteed water rate is as follows:

Kw. Output	Pounds Steam Per Kw.-Hr.
20,000	10.85
27,500	10.30
35,000	10.65

These units are designed for extraction of steam from two different stages in amounts as shown by the following tabulation:

EXTRACTION FROM 17TH STAGE

Load	Lbs. per Hr. Extraction Flow	Pressure at Extraction Flange Lb. per Sq. In. Absolute	Temp. 17th Stage Shell Deg. F
17,500 kw.	15,000 lbs.	3.55 lbs.	148
26,250 kw	22,000 lbs.	5.00 lbs.	162
35,000 kw.	34,000 lbs.	6.80 lbs.	176

EXTRACTION FROM 12TH STAGE

17,500 kw.	15,000 lbs.	28.0 lbs.	...
35,000 kw.	25,000 lbs.	53.5 lbs.	...

It will be noted that, on account of the compact design of these 35,000-kw. impulse machines, space is available in the turbine room for a switching gallery.

Full credit is given the Westinghouse Electric and Manufacturing Company for its help and co-operation in presenting a description of its turbines, particularly Messrs. L. C. Bullington and J. F. Johnson. Their frank and open attitude in supplying this information will surely be appreciated by many engineers.

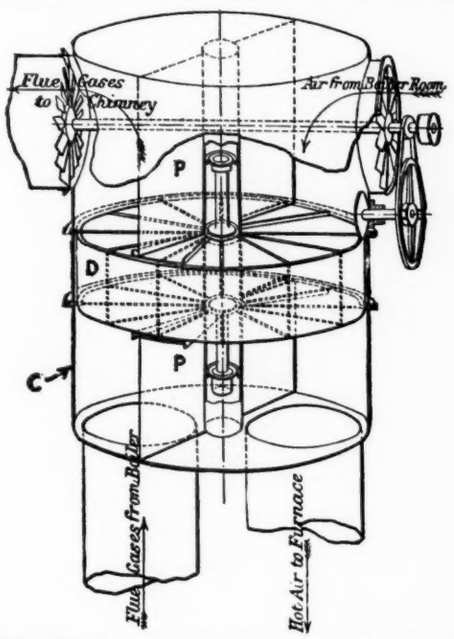
Acknowledgment is made to the General Electric Company for the information concerning their turbines. *Power* regrets that the policy of that company did not permit a reproduction of a cross-section through the turbine, as was done with the Westinghouse unit.

Another European Air Preheater for Boiler Furnaces

In *Power* for April 18, 1922, there was described a French air preheater which consists of a pile of thin rectangular plates held apart by spacing frames so designed that flue gas and air pass through alternate spaces about one inch thick. Heat transfer in this heater is effected by conduction from flue gas to air, through the sheet-metal plates. This method is open to the objection that the transferring metal plates may become coated with soot and tarry matter, greatly reducing the conduction of heat. A Swedish preheater which operates on an entirely different principle is described in *Engineering* (London) for July 7, 1922. Referring to the figure, air and flue gases are passed continuously in opposite directions through a vertical cylindrical sheet-metal casing *C*, divided in half by stationary vertical plates *P*, which form a partition between air and gas passages. Two fans, on the ends of a single horizontal shaft, serve to draw in fresh air from the boiler room and to discharge the gases into the stack after they have served their purpose of heating the air. Thus both induced-draft and forced-draft fans are incorporated with the heater.

The actual transfer of heat is effected by means of a slowly rotating porous drum *D* mounted on a vertical shaft through the center of the casing, and located about midway between top and bottom of the casing. This drum is of sheet metal and is divided into twelve sections by radial plates. In each sector is placed a mass of thin sheet-steel plates, kept at equal distances by a large number of small channel-shaped strips, spot-welded to the plates. The appearance of the top of the drum is similar to that of an automobile radiator. It is claimed that the large mass of porous radiating material offers little resistance to the flow of air and gases through the drum. As the drum slowly rotates, the mass of sheet steel in each sector picks up heat from the hot flue gases passing through one-half of the drum, and gives up this heat when it reaches the half of the casing through which the cold air is flowing.

It will be observed that there is no conduction of heat through metal in the process, aside from the negligible amount flowing through the stationary vertical plates forming partitions between air and gas passages. The



AIR PREHEATER USING NOVEL METHOD OF HEAT TRANSFER

main transfer is performed by the masses of porous material in each sector of the revolving drum, which are alternately subjected to the heating effect of the flue gases and to the cooling effect of the air as they pass from one half of the casing to the other. Heat is literally carried from flue gases to air.

This preheater is the invention of a Swedish engineer, Frederick Ljungstrom, of Stockholm. It is made by the Aktiebolaget Ljungstroms Angturbin, Arsenals-Gatan 2, Stockholm. It has been installed in several small hand-fired plants in Sweden, and comparative tests with and without the preheater have been run. In one case the boiler efficiency was reported increased from 66 to 77 per cent. The air for combustion was raised from 84 deg. F. to 275 deg. F., while the flue gases were cooled from 482 deg. F. to 253 deg. F. It must be noted that, when forced draft is used, cooling the flue gases to such a low temperature has no effect upon the draft.

The practical advantage of the Ljungstrom preheater lies in its compactness and light weight compared to an economizer designed to effect the same amount of regeneration by heating feed water. This makes it particularly well adapted to marine use, where small size and weight are objects of prime consideration.

Calculating Size of Synchronous Motor For Power-Factor Correction

By CHARLES A. ARMSTRONG

ANYONE who can accurately lay off distances on a sheet of paper may easily determine the size of a synchronous motor to correct the power factor of an alternating-current system. In this article the author works out problems by this method and shows how to draw conclusions from simple diagrams of alternating-current loads.

POWER-FACTOR correcting methods have come into such general use that the operating engineer who may have had little or no experience with such problems is called upon to make recommendations. The calculations for such work involve the use of trigonometry, but this need not prevent those who have not mastered this branch of mathematics from solving power-factor-correction problems, since the whole problem can be laid off on a simple diagram and the values measured off directly. All that is necessary is a little care in laying out the diagram and a table of natural sines and cosines. Such a table is given herewith.

The kilowatts, kilovolt-amperes and the reactive component of any alternating-current circuit can be shown to scale on a right-angle triangle. For example, take the case of a three-phase load where the voltmeter indicated 440 volts, the ammeter 500 amperes, the wattmeter 285 kilowatts and the power-factor meter

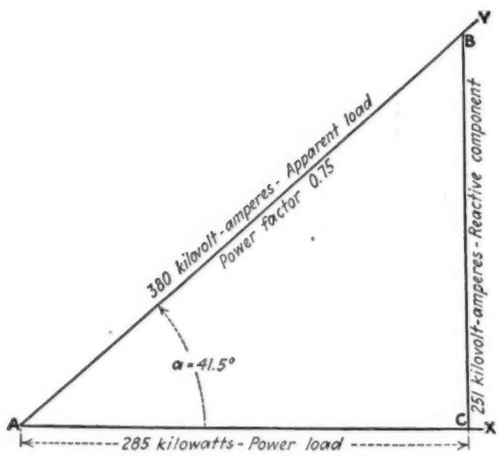


FIG. 1. DIAGRAM OF AN ALTERNATING-CURRENT LOAD

0.75 lagging. The kilovolt-amperes $= \frac{EI \times 1.732}{1{,}000}$ $= \frac{440 \times 500 \times 1.732}{1{,}000} = 381$. This value can be checked by dividing the wattmeter reading by the power factor, or in this case, 285 ÷ 0.75 = 380. These values are closer than might be expected in practice, because of the error in reading the instruments. We will take the wattmeter reading at 285 kilowatts and the kilovolt-amperes as 380. This load can be shown on a right-angle triangle as in Fig. 1, and the construction is as follows:

Draw a horizontal line AX and lay off on this line distance AC, to scale, to represent the kilowatt load. Say that 1 in. is allowed to represent 50 kilowatts, then the distance AC will be made equal to 285 ÷ 50 = 5.7 in. Next draw AY at an angle to AX equal to the angle of lag between the voltage and the current. The cosine of this angle is the power factor. If we look in the table under cosine and find the value 0.75, the angle corresponding to this will be the angle of lag between the voltage and current. The cosine of angle 41 deg. is 0.7547 and 42 deg. is 0.7431. The former is 0.0047 too great and the latter 0.0069 too small; if a value it taken halfway between the two angles, 41.5 deg., it will be close enough. Therefore

NATURAL SINES AND COSINES

Angle	Sine	Cosine	Angle	Sine	Cosine	Angle	Sine	Cosine
0	0.0000	1.0000	31	0.5150	0.8572	61	0.8746	0.4848
1	0.0174	0.9998	32	0.5299	0.8481	62	0.8803	0.4695
2	0.0349	0.9994	33	0.5446	0.8387	63	0.8910	0.4540
3	0.0523	0.9986	34	0.5592	0.8290	64	0.8988	0.4348
4	0.0698	0.9976	35	0.5736	0.8192	65	0.9063	0.4226
5	0.0872	0.9962	36	0.5878	0.8090	66	0.9136	0.4067
6	0.1045	0.9945	37	0.6018	0.7986	67	0.9205	0.3907
7	0.1219	0.9926	38	0.6157	0.7880	68	0.9272	0.3746
8	0.1391	0.9903	39	0.6293	0.7771	69	0.9336	0.3584
9	0.1564	0.9877	40	0.6428	0.7660	70	0.9397	0.3420
10	0.1737	0.9848	41	0.6561	0.7547	71	0.9455	0.3256
11	0.1908	0.9816	42	0.6691	0.7431	72	0.9511	0.3090
12	0.2079	0.9782	43	0.6820	0.7314	73	0.9563	0.2924
13	0.2250	0.9744	44	0.6947	0.7193	74	0.9613	0.2756
14	0.2419	0.9703	45	0.7071	0.7071	75	0.9659	0.2588
15	0.2588	0.9659	46	0.7193	0.6947	76	0.9703	0.2419
16	0.2756	0.9613	47	0.7314	0.6820	77	0.9744	0.2250
17	0.2924	0.9563	48	0.7431	0.6691	78	0.9782	0.2079
18	0.3090	0.9511	49	0.7547	0.6561	79	0.9816	0.1908
19	0.3256	0.9456	50	0.7660	0.6428	80	0.9848	0.1737
20	0.3420	0.9396	51	0.7771	0.6293	81	0.9877	0.1564
21	0.3584	0.9336	52	0.7880	0.6157	82	0.9903	0.1392
22	0.3746	0.9272	53	0.7986	0.6018	83	0.9926	0.1219
23	0.3907	0.9205	54	0.8090	0.5878	84	0.9945	0.1045
24	0.4067	0.9136	55	0.8192	0.5736	85	0.9962	0.0872
25	0.4226	0.9063	56	0.8290	0.5592	86	0.9976	0.0698
26	0.4384	0.8988	57	0.8387	0.5446	87	0.9986	0.0523
27	0.4540	0.8910	58	0.8481	0.5299	88	0.9994	0.0349
28	0.4695	0.8830	59	0.8572	0.5150	89	0.9998	0.0174
29	0.4848	0.8746	60	0.8660	0.5000	90	1.0000	0.0000
30	0.5000	0.8660						

draw AY at an angle of 41.5 deg. to AX and lay off on it AB equal to 380, using the same scale as for AC; namely, 1 in. equal 50 kva. This will make AC = 380 ÷ 50 = 7.6 in. If this is done carefully points B and C should be in the same vertical line. By drawing a line from B to C, the right-angle triangle is obtained as in the figure. The side BC is known as the reactive component of the load and is equal to the wattless current in the circuit times the volts. It is also equal to the kilovolt-amperes times the sine of angle a. Referring to the table, the sine of angle 41.5 deg. is between 0.6561 and 0.6691, or about 0.66, and 380 × 0.66 = 251 kilovolt-amperes reactive component. With the load on the system laid out in a diagram as in Fig. 1, we are in a position to determine the effects of any other load that might be added.

Take, for example, the case where a 100-hp. load is to be added to the system and this load is to be driven by a synchronous motor. There are two things that may be done; namely, install a motor just large enough to drive the load and operate it a unity power factor, or install a motor larger than necessary to drive the

load and use the excess capacity for power-factor correction by over-exciting the fields of the motor.

First, consider the case where a 100-hp. motor is installed to operate at 100 per cent power factor. Taking the motor efficiency at 95 per cent, the electrical input from the alternating-current lines to the motor will be $100 \div 0.95 = 105$ hp., or $(105 \times 746) \div 1{,}000 = 78$ kw. To add this load to the present load, extend

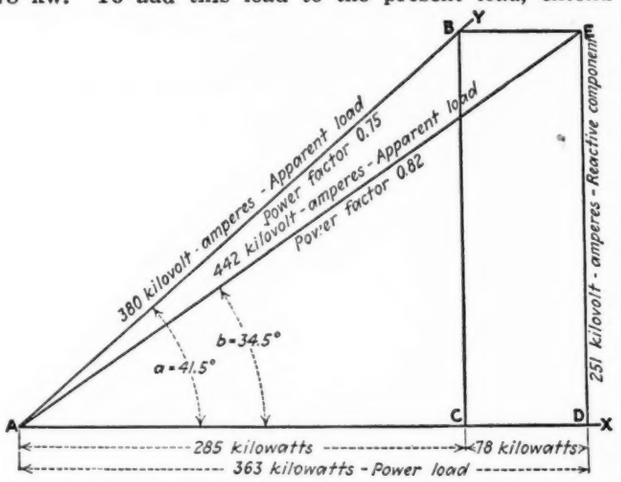


FIG. 2. DIAGRAM OF LOAD, FIG. 1, WITH 100-HP. UNITY-POWER-FACTOR SYNCHRONOUS MOTOR ADDED

the line *AC*, Fig 1, to *D*, as in Fig. 2, and make *CD* equal to 78. This gives a total kilowatt power load of $285 + 78 = 363$. In all cases the kilowatt loads are added arithmetically since these loads are at unity power-factor.

From *D*, Fig. 2, erect a perpendicular and draw a line from *B* parallel to *CD* to intersect the perpendicular at *E*. Join *AE* and then the right triangle *AED* will represent to scale the new load conditions on the system with the 100-hp. unity-power-factor motor added. This is the condition that would exist provided the motor was fully loaded. At less than full loads the power factor of the motor would become leading and tend to hold the power factor of the system the same as with full load on the motor. To what extent the motor will accomplish this end will depend upon its characteristics. In any case the power factor of the system will be less than with the motor loaded and the field coils excited to give unit power factor.

The line *AE* represents to scale the kilovolt-ampere load on the system. If 1 in. equals 50 kilovolt-amperes, the length of *AE* would be found to be 8.84 in. and $8.84 \times 50 = 442$ kva. By measuring angle *b* with a protractor it will be found to be equal to approximately 34.5 deg. The cosine of angle 34.5 deg. is found from the table to be about 0.82, which is the new power factor of the system. The new power factor may also be obtained by dividing the kilowatt load (363) by the kilovolt-ampere load (442), or $363 \div 442 = 0.82$. From this it is seen that by adding a 100-hp. motor unity power factor to the system the power factor of the load has been corrected from 0.75 to 0.82. If it is desired to obtain a better power factor and add only 105-hp. mechanical load, 78 kw., to the system, it will be necessary to install a motor larger than 100 hp. and use the excess capacity for power-factor correction by over-exciting the motor fields. How much larger the motor should be will depend upon how much it is desired to correct the power factor. It hardly even pays to correct the power factor above 90 per cent, therefore it will be assumed that the power factor of the load, Fig. 1, is to be corrected to 0.90 by adding a synchronous motor that is to drive a 100-hp. mechanical load. The kilowatt input to this motor will be about the same as for the unity power-factor motor, or 78 kw., and will be assumed to be the case in the new problem.

To start with the solution of the new problem, a load diagram is made as in Fig. 2. This figure is represented by the outline *ABEDCA*, Fig. 3. The power factor is to be corrected to 0.90. Referring to the table, it is found that 0.90 corresponds to the cosine of an angle of about 26 deg. With a protractor lay off an angle of 26 deg. with *AD* and draw *AF* at this angle to *AD*. Then draw *BF*, and the right triangle *BEF* will represent to scale the synchronous motor load to be put on the system to correct the power factor from 0.75 to 0.90 and at the same time do 100 hp. of mechanical work. The line *BF* represents the size of the motor and scales off about 108 kva. The cosine of the angle between the kw. and kva. line (angle *c*) is the power factor. In this case this angle measures about 44 deg., and the cosine of 44 deg. is about 0.72, which is the leading power factor at which the motor will operate. The motor will supply a capacity reactive component of 73 kva. and this substracted from the 251 kva. inductive reactive component of the original load leaves 177 kva. inductive reactive component in the new load. The line *AF* represents to scale the new load on the system, or 404 kva. From this it is seen that although 108-kva. load had been added to the system, the total load has increased only from 380 to 404 kva. on an increase of 24 kilovolt-amperes.

If it were desired to correct the power factor to unity, the size of the synchronous motor required could be obtained by scaling the distance from *B* to *D*. This distance gives a motor capacity of about 260 kva., and the kilowatts *BE* divided by the kilovolt-amperes *BD* (or $78 \div 260 = 0.30$) gives the power factor of the

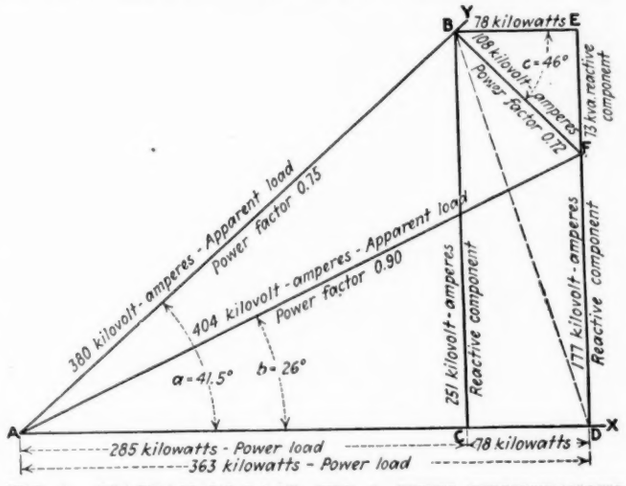


FIG. 3. DIAGRAM OF LOAD, FIG. 1, WITH SYNCHRONOUS MOTOR ADDED TO CORRECT THE POWER FACTOR TO 0.90

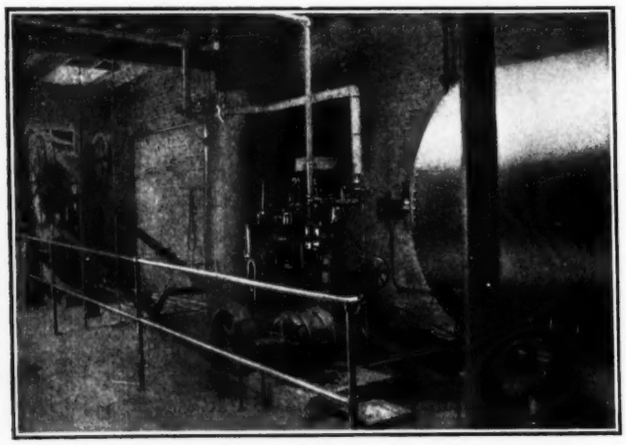
synchronous motor. Under this condition the kilovolt-ampere load will equal the kilowatt load. In other words, by adding a 260-kva. motor to the system to do 100-hp. mechanical work and operating at a leading power factor of 0.30, the total load on the system does not increase but decreases from 380 kva. to 363 kw. However, this is not warranted on account of the large size of motor required to correct the power factor. Where it only required an increase in capacity of the

motor from 78 to 108 kva. to correct the power factor to 0.90, it required an increase to 260 kva. to correct it to unity, an increase from 30 to 182 kilovolt-amperes.

Referring to Fig. 2 shows that adding the 100-hp. unity-power-factor motor to the system increased the load from 380 to 442 kva. However, by correcting the power factor to 0.90, the load on the system will be reduced from 442 to 404, or 38 kva., but the motor capacity has been increased only from 78 to 108, or 30 kva. In this case the increase in motor capacity is more than compensated for by the reduction in generator capacity necessary to carry the load. As pointed out in the foregoing, it does not pay to correct the power factor much beyond 90 per cent, and this is evident from the large increase in motor capacity required to raise the power factor from 0.90 to unity, as indicated in Fig. 3. Of course, if the power factor of the system was about 0.90 and a unity-power-factor synchronous motor load were added, then the power factor would be automatically raised above 0.90, and less generator capacity would be required than added motor capacity. On the other hand, by installing an induction motor its power factor would be less than 0.90 and would tend to reduce the power factor of the system, making it necessary to increase the generator capacity more than the added motor capacity. The extent to which the system is affected will depend on the size of the system and the increase in motor load.

Unusual Automatic Installation of Deep-Well Pump

The accompanying illustration shows an installation at St. Joseph's Hospital, Joliet, Ill., of a Goulds 24-in.-stroke deep-well-working head with double-acting cylinder



PUMP, DRIVEN BY STEAM ENGINE OR MOTOR, IS ENTIRELY AUTOMATIC

located 300 ft. in the well; also a 3 x 4-in. Triplex pump for pumping the water into the pressure tank, the deep-well head pumping only into the vertical storage tank. This is believed to be the only installation of its kind in the United States that is entirely automatic. The pump is operated by electric motor in the summer, and in the winter is operated by steam engines, utilizing the exhaust steam for heating purposes. The outfit is equipped with automatic starter and pressure-regulator for the electric motor and a throttle valve automatically operated for the steam engines.

Atomizing Cylinder Lubricating Oil

By W. F. Osborne
Supervisor Manufacturers' Service, Texas Company

As was explained in the last article, perfect atomization is a most important factor in obtaining efficient and economical steam-cylinder lubrication. It now remains for us to determine what constitutes perfect atomization and how it may be obtained.

What is the proper size of the globules of oil? Is a large globule better than a small one and how many of them should there be? Other things being equal it

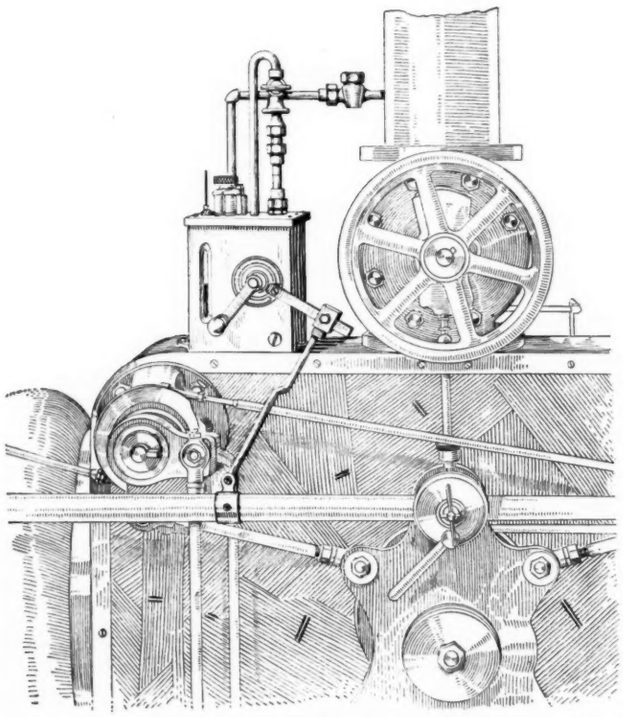


FIG. 1. MECHANICAL LUBRICATOR

would seem that a lot of globules would be better than a few, because there would be more of them to be distributed upon the various surfaces requiring lubrication. A few large drops certainly could not be distributed over as large a surface as the same quantity of oil divided up into a much greater number of smaller drops.

Now then, how big should they be? Obviously we can get a larger number of globules from a given quantity of oil by making them smaller. Therefore we can save oil by making the drops as small as possible, provided there are enough of them to spread a thin film over the surface. A large droplet of oil will be blown off the cylinder wall more quickly than a small one because it presents a greater surface to the steam. Practical experience shows us that best lubrication can be obtained by dividing the oil up into the smallest possible drops, thereby forming the greatest possible number from a given quantity of oil.

Furthermore, a finely atomized oil will remain in suspension in the steam better than one divided into larger drops. The surface in contact with the steam per unit of weight is greater, and there is not so great a tendency for the oil to be thrown out of the steam

at the turns. An improperly atomized oil will collect in any pockets in the pipe-turns or in the valve chest, and of course will not be carried to the parts where it is needed. Such oil is wasted.

The factors that influence the size of the drops are the mechanical means available for atomization, steam velocities, moisture in the steam, temperature, and physical properties of the oil.

When oil is delivered by a mechanical or hydrostatic lubricator to the end of a pipe in the steam line, steam chest or cylinder, it may be in the form of a large drop, or spread out flat over a considerable surface. If the lubricator is located so that the feed pipe remains completely full all the time, at each stroke of the pump a little oil will ooze out at the end of the pipe and will be wiped off and carried away by the steam.

Should there be a short section of horizontal oil pipe, as is frequently the case when the oil is fed into the steam line, the lower half of the pipe will be filled with oil and the upper part with steam. Now, if the end of the pipe terminates at the inside wall of the steam pipe as shown in Fig. 3, at *A*, the oil will ooze out and run down the side of the pipe for a long distance before it will be completely scoured off by the steam, but if the pipe be extended to the center of the steam line as in *B*, the oil oozing from the end will be picked up by the steam at once and carried to the cylinder. It is quite evident that the oil will be more finely divided and will be distributed throughout the steam more evenly when it is delivered to the center of the steam flow, than when it must be picked up from the side of the pipe as shown in the first case.

Sometimes, when the steam pipes are large and a considerable quantity of oil is required, it is advisable

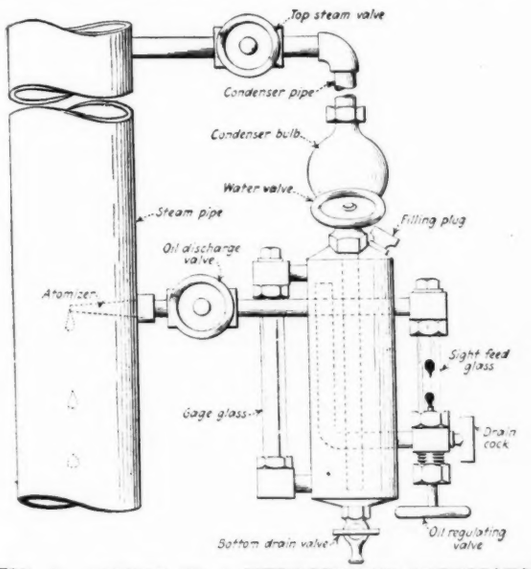


FIG. 2. ACTION IN A HYDROSTATIC LUBRICATOR

to extend the feed pipe all the way across the steam line, attaching it solidly to the opposite wall. A number of small holes drilled through the feed pipe, as outlined in Fig. 3 at *D*, permits the steam to flow through, thoroughly atomizing the oil and distributing it in the steam.

Should the feed pipe be located so that the oil line drains from the lubricator to the steam pipe or cylinder, then the line will be partially empty all the time, and the oil will flow down one side, issuing from the end in small drops, the size of which depends upon the characteristics of the oil, the temperature and the amount of oil available. The best arrangement will be such that the end of the pipe is exposed to the direct flow of steam so that the oil drops can be picked up by the steam and carried away, as at *C*.

The best distribution of the oil can be obtained when the oil is fed in small quantities regularly at frequent intervals, rather than in larger quantities at longer intervals. This is one reason why the mechanical lubricator is more economical in the use of oil than the

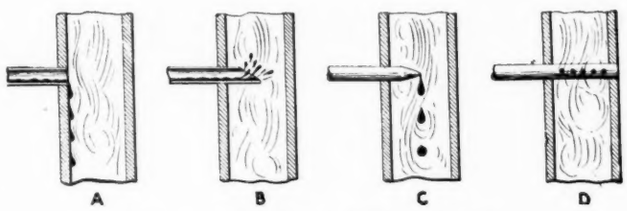


FIG. 3. FORMS OF ATOMIZER TIPS

hydrostatic lubricator. The latter necessarily feeds a large drop a few times per minute, and a large quantity of oil is delivered into the steam at irregular intervals. The mechanical lubricator will take the same quantity of oil, split it up into smaller quantities delivered at frequent intervals, and the steam will be more evenly lubricated.

Another very important influence is the time element. The atomization of a drop of oil delivered to the steam depends, to a large extent, upon the time allowed for its atomization and distribution through the steam, before the steam reaches the cylinder walls. When the oil is fed directly into the top of the cylinder, there is very little opportunity for thorough distribution and mixing of the oil and steam, before the oil goes out through the exhaust. Feeding the oil into the steam chest helps, in that it has more time before it reaches the cylinder, and feeding the oil into the steam line is still better. In fact, the best results are obtained by feeding the oil into the steam line some distance back from the throttle. Any engineer can try this for himself and will find that when suitable oils are used, there will be much better atomization if the oil is introduced into the steam line six or eight feet from the throttle than if it is fed in just above or below the throttle. The improved atomization is quickly noticed in the smaller quantity of oil required for satisfactory lubrication. This one change will sometimes cut down the oil consumption by from twenty to thirty per cent, or will give satisfactory lubrication when it was impossible to obtain good lubrication before.

Another mechanical effect, or influencing factor, in oil atomization is the velocity of the steam. When steam strikes a surface coated with oil, such as the end of the spoon-shaped feed pipe shown in Fig. 3, at *B*, a high velocity will spread the oil out finely, dividing it and distributing it thoroughly throughout all the steam. A low velocity will not have such a good effect, and no velocity at all will allow the oil to drip off the end of the pipe in large drops. A high velocity, of course, does not give the oil as much time to atomize before it reaches the cylinder, and it is sometimes desirable to move the point of feed further back from the throttle under such conditions.

Care of Valves on Diesel Engines

By LOUIS R. FORD

THE maintenance of a Diesel engine in good operating condition calls for very careful supervision of the cylinder-head valves. These valves operate under about the most difficult conditions that can be found in any kind of service; they are subject to high pressure, intense heat and the action of corrosive agents in the fuel and the gases resulting from its combustion.

NAMING them in the order of their relative influence on engine operation and their liability to derangement, the cylinder-head valves on four-stroke-cycle engines are: Fuel-spray or injection, exhaust, air-inlet, air-starting and relief. On two-stroke-cycle engines the exhaust and air-inlet valves are omitted and, except where port scavenging is used, scavenging valves are added.

There are two general forms of spray valve design—the needle type (Fig. 1-B) and the mushroom or disk type (Fig. 1-A). Superior advantages are claimed for each type, but from the point of view of maintenance there is little choice. In all closed-nozzle types of valve the oil and air are admitted to a chamber in the main body of the valve, the oil lying at the bottom of the chamber adjacent to the opening into the cylinder, and injection is accomplished at the proper time by raising the valve off its seat in the case of the needle type, or

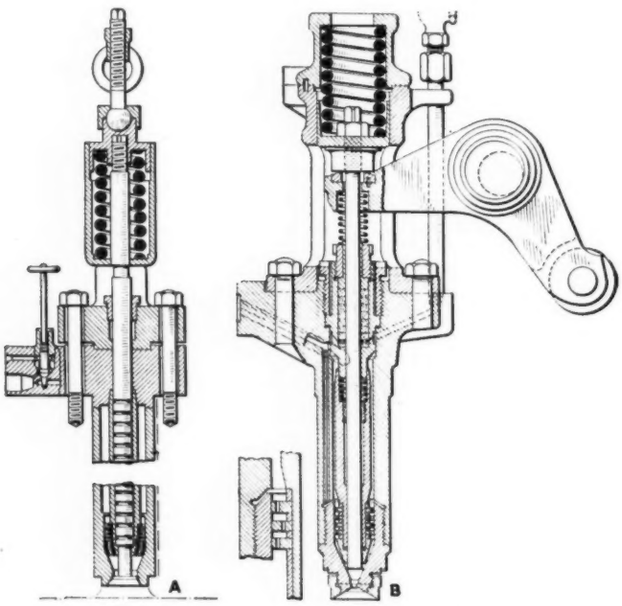


FIG. 1. TYPICAL FUEL-SPRAY VALVES

pushing it downward off its seat in the case of the mushroom type. The spray-valve troubles most commonly encountered are scoring and cutting of valve and seat, causing valve to leak; jamming of stem in its guide, preventing valve from seating; valve-stem packing leaking; and atomizer plates or passages clogged, preventing flow of oil and air out of valve body. In the case of a leaky seat or valve its correction may involve more or less regrinding, depending on the depth of the cuts or scores on valve and seat. In no case should recutting or facing be resorted to if it is possible to make the valve tight by grinding, but it should be remembered that frequent regrinding is likely to result in the seat wearing out of true or the valve face becoming uneven.

When regrinding, use only a very fine grade of powdered glass or carborundum, made into a paste with oil. All grades of emery are too coarse for this purpose. While ordinary lubricating oil is most commonly used for mixing with the powder, it will be found that kerosene will give the best results. A number of grind-

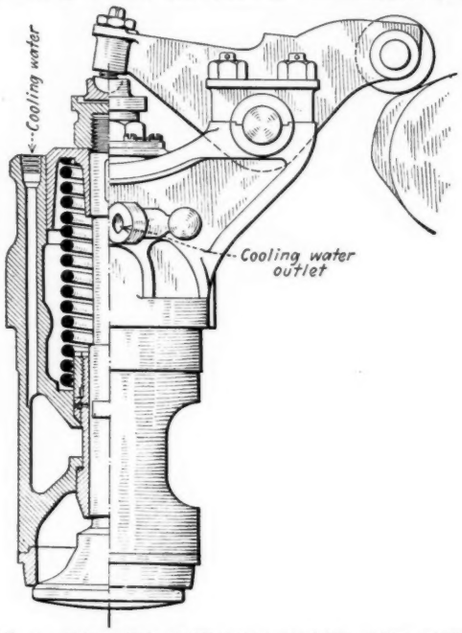


FIG. 2. MODERN EXHAUST VALVE AND CAGE

ing compounds made up in the form of paste are on the market, and most of these are good provided the finest grade is used. The grinding paste should be applied very sparingly and care should be exercised to prevent any of it from getting on the valve stem where it may cut the guide. After a good even seat has been obtained all around, valve and seat should be cleaned, then finish-ground with a coat of fuel oil.

Some engine builders supply a special reamer for truing the spray valve seat, but if it is not supplied, the engineer should have one made. The reamer should be a duplicate of the valve, with the face fluted to form cutting teeth. The reaming should be very carefully done to obtain good results. The reamer should not be dropped down on the seat nor should very much pressure be applied, as it will chatter and cut an irregular seat. Insert the reamer carefully, hold against the seat with a light pressure and turn only in one direction. If it is turned backward the chips collected between the cutting teeth will scratch the valve seat and a great deal of grinding will be required to remove the scratches. The liability to scratch will be reduced if the cutting teeth are coated with heavy cup grease.

This grease will catch and hold the metal chips and prevent them being dragged under the teeth. Remove the reamer frequently, clean and recoat with grease, wipe out the valve seat and continue the operation only long enough to obtain a good full seat, without removing any more metal than is necessary.

It is general practice to make the valve seats of cast iron and the valves of high-grade alloy steel, hardened. For this reason it is usually the valve seat that requires recutting and the valve need be ground only to the seat, but when the valve is scored enough to require recutting it is best done in the lathe, using a center grinder in the compound rest as a cutting tool. The rest is set to the angle of the valve seat and very light cuts are taken, using a soft grinding wheel and revolving the valve about 200 revolutions per minute.

The spray-valve stem guide is usually made as long as possible in order to reduce the wear and insure the valve seating absolutely true. It is a common mistake among engineers to assume that sticking of the valve stem in the guide is due to a too close fit between stem and guide. As a matter of fact it is in most cases caused by this fit being too loose. The spray air pressure inside the spray-valve body tends to force the fuel oil up into the space between the guide and stem, especially when leakage of air past the valve-stem packing creates a condition of unbalanced pressure in the valve-stem guide. This fuel oil is spread in a thin film over the surface of the valve stem, and the heat of the stem gradually cooks it down to a gummy condition. This gum or soft carbon is very gritty, with no lubricating value, and will soon cause the stem to stick in its guide. When the spray valve is disassembled for overhaul, the stem and guide should be carefully cleaned with kerosene. Emery cloth should not be used to polish the stem unless it is too rough to be cleaned with

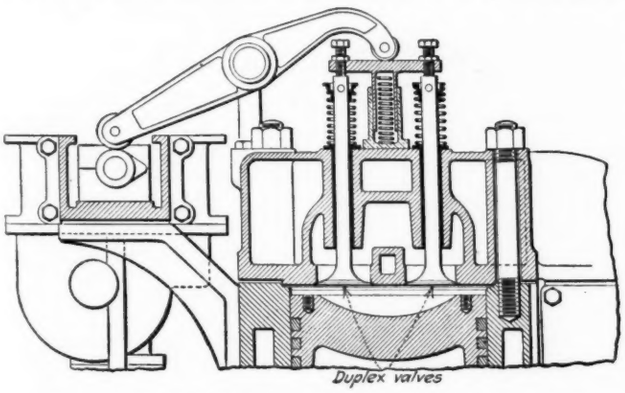


FIG. 3. CYLINDER HEAD WITH DUPLEX EXHAUST VALVES

oil, as it tends to reduce the diameter of the stem and increase its clearance in the guide.

Spray-valve stems are packed with high-grade soft packing or metallic packing. In replacing, do not use packing that contains rubber. Rubber is readily solvent in fuel oil and the packing will be destroyed rapidly. If the stem shows cuts or abrasions where the packing bears, it should be smoothed and polished with emery cloth to prevent the packing from being torn.

If the valve stem is bent, it should be straightened and spun between centers to see that it runs true. Do not replace a stem that has been straightened without testing the seating of the valve. If the spring has taken a permanent set that shortens it enough to decrease its working tension, place enough washers under the spring or on top of it to give it the right tension. Since it is not practicable in the ordinary engine room to measure this tension, the engineer must necessarily set it by observing the action of the valve. The tension should not be so great as to put unnecessary load on the operating gear, but it should be enough to overcome the inertia of the valve levers and push rods and permit the valve to snap rapidly back to its seat after the pressure of the valve lever is removed.

Exhaust valves in the small sizes are made of alloy steel, but for the larger sizes it is becoming more and more customary to make the valve of cast iron, with chilled surfaces, and fit it on a steel stem. Leaky ex-

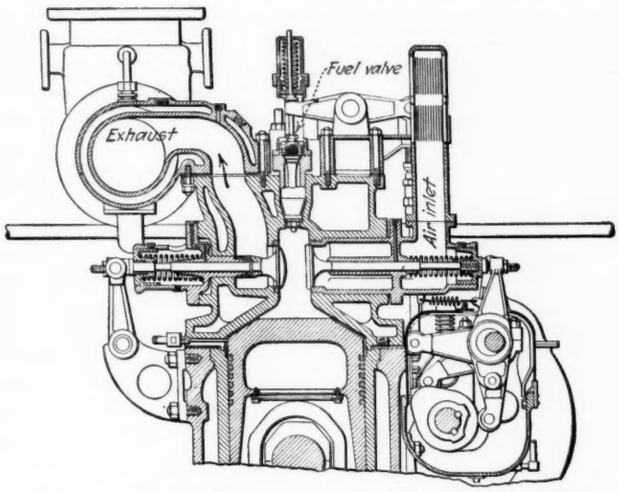


FIG. 4. ARRANGEMENT OF VALVES ON A VERTICAL DIESEL

haust valves may be due to any of the following causes: Cutting effect of the highly heated gases passing at high velocity between valve and seat; carbon or dirt from the fuel becoming caught between valve and seat and hammered into the metal; corrosive effect of acid in the fuel; warping of valve disk, causing uneven seating; valve stem sticking in guide, preventing the valve from seating firmly.

When regrinding an exhaust valve, it will usually be found necessary to remove considerable metal to get a good seat, so a rather coarse grade of grinding compound may be used at first, finishing up with the fine grade. If the valve is cut or scored too badly to regrind by hand, recourse must be had to the lathe and grinding wheel, as the metal is too hard to be cut by a lathe tool or reamer.

On new engines it will nearly always be found that both the exhaust and air-inlet valves will take a permanent set after a short time in use and must be taken out for regrinding, after which they are less liable to deformation. In the case where exhaust and air-inlet valves are duplicates, it is advisable after a few weeks running to interchange them. This is known as "seasoning" the valves. In some engines, especially the larger sizes, the blow-torch action of the fuel spray causes the exhaust-valve disk to become much hotter on the side adjacent to the fuel-injection valve. This uneven heating may cause serious warping of the valve. If the valve construction is such that the valve can be rotated by means of a wrench on the upper part of the stem while the engine is running, the operating routine should call for giving the valves a turn at least once

every hour. This will tend to prevent permanent warping, due to the uneven heating.

Sticking of the exhaust-valve stem in its guide may be caused by too much clearance permitting gummy oil and carbon to work up between stem and guide, as in the case of the spray valve. This action is accelerated when very heavy fuel oil is being used, by the fact that the heavy, unburned residue that may be carried in the exhaust gases in a finely divided state strikes against the exhaust-valve stem and sticks. This action occurs when the valve is pushed downward to the open position, thus exposing a part of the stem that travels up into the guide when the valve closes.

When a valve is removed for overhaul, the stem should be carefully cleaned, as described in the case of the spray valve. Both the valve and its seat should be examined for fine heat cracks that may develop into leak paths. It is good practice to run kerosene through the valve-stem lubricator occasionally while the engine is in operation. This tends to clean out gummy oil that may collect in the guide.

The treatment of air-inlet valves should be the same as for the exhaust valves, but it will be found that they will not require regrinding as often. Due to the cold air passing through the inlet valve during the suction stroke, it never gets as hot as the exhaust valve, and it has none of the dirt and unburned oil in the exhaust gases to handle. A leaky inlet valve can be detected by a whistling noise in the intake pipe, and it may sometimes be stopped by rotating the valve on its seat.

The whole matter of cylinder-head valve maintenance should be treated in an orderly manner. The operating routine should provide for examination and overhaul of these valves at regular intervals and each valve should be examined, cleaned and given such repair as may be found necessary before it has a chance to cause trouble.

Direct-Current Automatic Reclosing Circuit Breaker

An automatic-reclosing circuit breaker for use on direct-current circuits of 300 and 600 volts has recently been developed. The operation on stub-end feeds, where there is only one source of power to the load, is typical, and its description will serve to give an idea of how the apparatus functions. The devices that go to make up the equipment are a shunt contactor, an instantaneous overload relay, a reclosing relay, a control power switch and a load-indicating resistor. These devices are connected in accordance with the wiring diagram shown in Fig. 1. The sequence of operation in case of short-circuit or heavy overloads on the feeder is as follows:

The overload relay opens its contacts, de-energizing the coil of this contactor, which opens, disconnecting the load from the source instantaneously. When the contactor opens, it closes auxiliary switch *B*, which energizes the coil of the time-delay circuit-closing relay, which starts to close. The time-delay is inserted at this point in the sequence in order to allow conditions on the feeder to become stable. The closing of this relay completes the circuit through the lower coil of the reclosing relay.

The reclosing relay has two coils, and, to operate, must have both of them energized. Its operation resembles somewhat that of a voltmeter, the lower coil being analogous to the permanent magnet of the meter, and the upper furnishing excitation to the movable element on which the contacts are mounted. The relay contacts will close only when the voltage drop across the load, with which the upper coil is in parallel, is enough to cause that coil to excite the movable element sufficiently to close them. When the load resistance is practically zero, as in case of a short-circuit, there is no voltage across the upper coil and the circuit will be from the busbar, through the right-hand side of the control power switch, load-indicating resistance, the

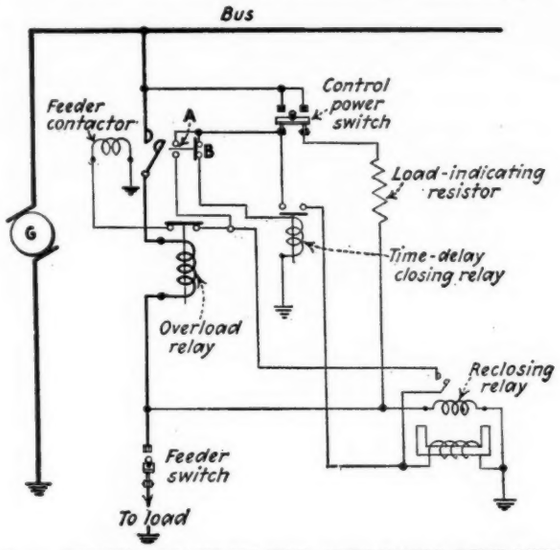


FIG. 1. WIRING DIAGRAM FOR AUTOMATIC RECLOSING CIRCUIT BREAKER

feeder switch through the fault and back to the generator. When open-circuit conditions exist, there is practically full voltage across the upper coil, because its resistance is so much greater than that of the load-indicating resistor. Therefore it is possible to obtain an intermediate point, and calibrate the reclosing relay so that with a definite value of resistance in the load-indicating resistor, the equipment will not close on a load in excess of a predetermined value.

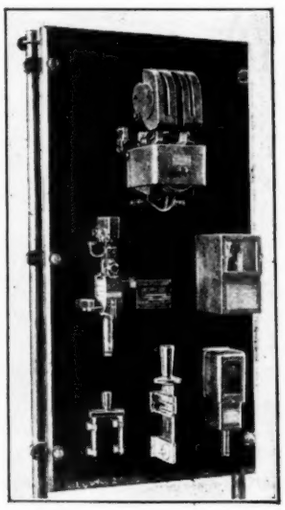


FIG. 2. RECLOSING CIRCUIT-BREAKER PANEL BOARD

As long as the trouble on the feeder continues, the reclosing relay will remain open, even after the time-delay relay has closed, because the voltage across the load is not enough to close the contacts. As soon as the trouble has cleared, and the load resistance has passed the predetermined point, the relay will close, energizing the coil of the feeder contactor, which closes, closing the auxiliary switch *A* and sealing it in. The closing of the contactor reconnects the load and de-energizes the time-delay relay, which opens its contacts.

The equipment for circuits having a combination of stub-end and multiple feed makes use of a contact-making voltmeter to indicate when the potential difference between the feeder and the source has fallen to a safe reclosing value. When the voltage has so fallen,

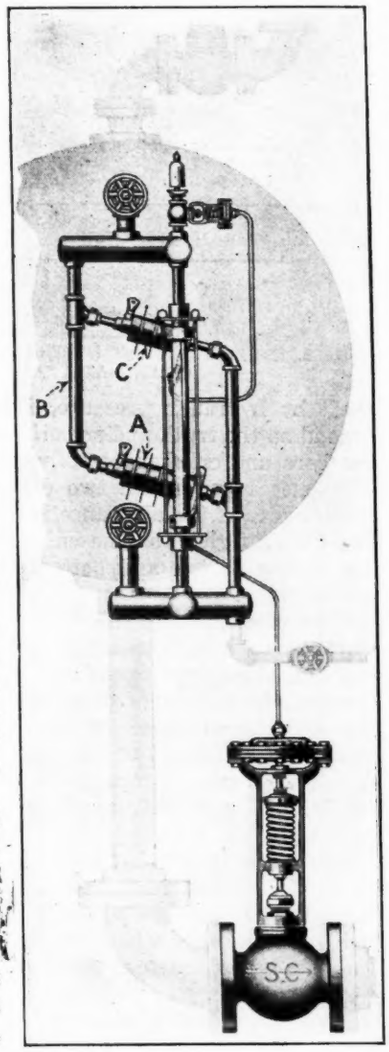
the feeder contactor recloses in the same sequence as in the former case. A relay connected in parallel with the contact-making voltmeter determines whether the equipment is to operate on multiple or a stub-end feed. The automatic reclosing equipments are especially valuable in mine installations, for use on circuits supplying power to hoists, cutting and drilling machines, mine trolley systems, etc., in industrial plants and on street railways, and have been developed and recently placed on the market by the General Electric Company of Schenectady, N. Y.

"SC" Drainage Control Adapted from Boiler-Feed Device

The principle of operation used for some time in the boiler feed-water regulation device of the "SC" Regulator Manufacturing Co., of Fostoria, Ohio, has lately been utilized in the design of a receiver drainage-control device which is meant to take the place of a number of traps in various parts of the plant, allowing the condensation to be brought into one central receiver. The construction of the apparatus is such, according to the manufacturer, as to make it suitable for pressures up to 600 lb., and the absence of moving parts is pointed out as a means of cutting down maintenance expense.

The equipment is really made in duplicate; one part acts as a trap, letting water out of the receiver as fast as it collects there, and the other part blows a whistle in case the water level rises too high, thus giving warning in time to prevent trouble with water in turbines, engines, etc.

The illustration shows the control equipment installed on the end of a receiver tank. Water is let out of the latter through the valve at the bottom of the illustration, which, of course, must be closed before the level falls too far. The valve is operated by water pressure on a diaphragm above it, the pressure being carried to the diaphragm through the small pipe from the cylinder *A*. This cylinder is really a water jacket around the pipe *B*. This pipe is connected with the tank in much the same way as the gage glass, so that the water level in it remains the same as in the tank.



"SC" EQUIPMENT FOR CONTROLLING THE DISCHARGE OF HIGH-PRESSURE DRIPS FROM A CENTRAL RECEIVER

Water is discharged through the valve at the bottom, which is hydraulically controlled by changes in the water level inside the tank.

When the water level falls inside the tank, therefore, it falls also in the pipe *B* and finally reaches the right-hand end of the cylinder *A*. Steam then fills the part of pipe *B* that is inside of the cylinder and since the steam is hotter than the water inside the pipe (the water loses heat by radiation), the temperature of the water inside *A* surrounding the pipe *B* is increased; the resulting increase of pressure in the surrounding water is communicated through the small pipe to the diaphragm, closing the valve and shutting off the escape of water. When the level rises in the inside tube in *A*, the surrounding water becomes cool (with the aid of the radiating fins), the pressure on the diaphragm is reduced, and the spring under the latter opens the valve and allows the escape of water until the level again comes down.

It will be noticed that a duplicate cylinder *C* is installed directly above *A*. This is for the operation of the whistle, and works in the same way as the other cylinder. The increase in pressure of the surrounding water in this case is carried through the small tube to a valve that operates the whistle, thus providing a high-water alarm.

Alignment of Steam Engines

By Thomas W. Airey

One of the most common errors in the alignment of an engine and the one that is most difficult to locate is a want of parallelism between the axial line of the crankpin and that of the crankshaft. An engineer may be troubled with a knocking or pounding of the engine and may spend a lot of time trying to discover the cause. Although it is one of the most common faults, the idea that the crankpin is out of alignment with the crankshaft is seldom given consideration.

An error in this direction may arise from several sources. A want of truth in the boring out of the crank hub or of the throw for the crankpin will cause misalignment. These may be caused by the method of securing the crank to its shaft. Too great an allowance for contraction or improper heating of the crank hub will also throw the pin out of alignment. Bad machining of the hub bore and its seating on the shafts are frequently at fault.

Inaccuracy of Boring Machine

If the machine table on which the crank is fixed for the purpose of boring is out of truth, the inaccuracy will be reproduced in the bore of the holes. Should the crank or crank disk be mounted on the faceplate of the lathe, the same will happen under similar conditions, the holes will be out of truth to twice the amount the faceplate may be out.

In Fig. 1A is shown a crank disk, the face *f* having already been machined, mounted on the faceplate *a* of the lathe for the purpose of boring for the shaft and pin. The faceplate is shown as being worn hollow. In this operation the checking of the crank disk will be practically true, the bore *b* for the crankshaft being true to face *f*, this being explained by reason of the disk

covering an equal distance on each side of the faceplate center, making the disk square with the spindle. Now suppose we move the work on the faceplate for the second operation, that of boring for the crankpin hole *P* into the position shown in Fig. 1B. The bore of the crankpin hole *P* will not be parallel to the bore of the crankshaft *b*. The reason for this is that the disk is now more on one side of the faceplate than on the other, and the hollowness of the faceplate throws the disk out of truth.

In the larger type of engines the method of dealing with the crank or crank disk is somewhat different. It is usual to machine one surface as a first operation either by planing or milling. The crank is then mounted on the machine table and the hole for the shaft bored out and the hub faced. The hole for the crankpin is next roughed out, sufficient material being left for a final cut after the crank is secured to the shaft. The crank is next pressed on the shaft and keyed up. The crankshaft is then put between the lathe centers and the crank trued up and finished to size. The final operation of boring the pin hole is transferred to a horizontal boring machine. By this method the inaccuracy caused by the mounting of the crank or crank disk on a faceplate or machine table that is out of truth and boring both holes, is obviated. The greatest care must be exercised in the setting for the final boring of the pin hole with the second method. An error may be induced when securing the crank to its shaft by reason of the key

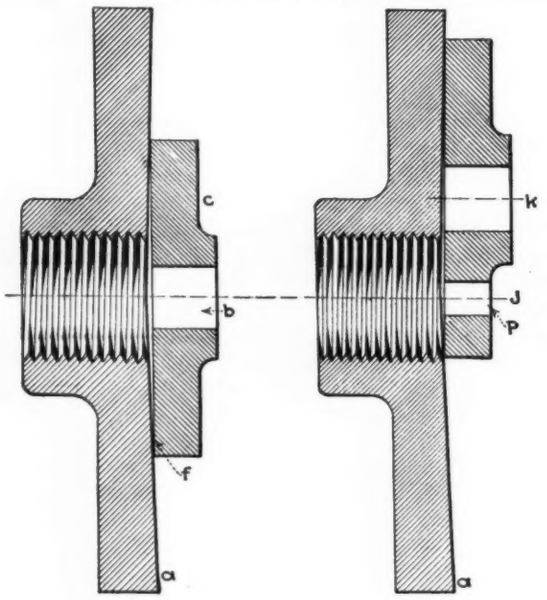


FIG. 1. METHOD OF BORING FOR SHAFT AND CRANKPIN ON A LATHE

springing the crank out of truth. This is liable to occur from a want of parallelism in the bore of the hub on the turning of the shaft, the key springing the crank over on the side at which it is the easiest fit.

In Fig. 2 let *a* represent the crankshaft, *B* the crank shown partly in section, *c* the key. If the crank hub has a slightly easier fit on the shaft at *f* than *g*, then the key *c*, supposing it to fit correctly top and bottom, would, when driven home, force the crank over, and so throw the axial line *h* of the crankpin out of parallel with the axial line *J* of the crankshaft as shown in the figure.

Suppose that the crank is to be contracted on the shaft and that the bore of the hub and the machining of the shaft are perfectly parallel. An error may be induced by the improper heating of the hub. Referring to Fig. 2, it will be noticed that the hub of the crank at *b* is much weaker than at the throw end *d* and is likely to give most in the process of contraction. It follows that if the weak part *b* is made hotter than *d*, it will give more and this will throw the crank out of truth.

Similar results are liable to happen if an excessive amount of difference is made in the diameter of the bore of the crank hub and the diameter of the crankshaft for contraction. If the crank is to be put on the

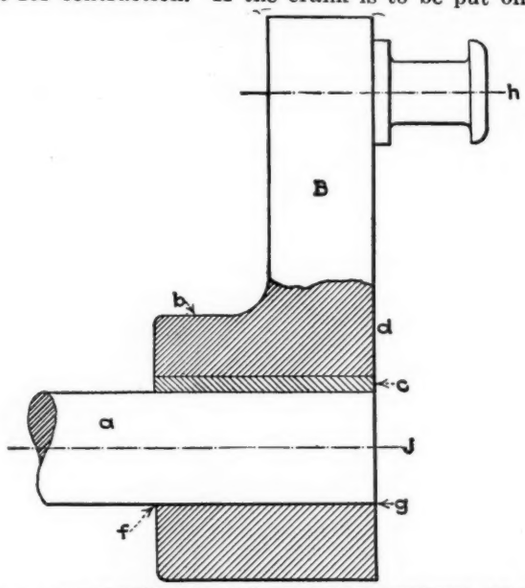


FIG. 2. MISALIGNMENT BY IMPROPER KEYING OF THE CRANK-ARM TO SHAFT

shaft by hydraulic pressure, its fit on the shaft will depend on the truth and smoothness of the machining of the bore and crankshaft, as well as on the amount of difference between the two diameters allowed for the forcing fit. If the allowance for the forcing fit is small and the fit tighter at one end than the other, then the key fitting at top and bottom would force the crank out of truth.

When the surfaces are not smooth but contain tool marks or ridges, unequal pressure of the key at one end will throw the crank out of truth. The driving home of the key compresses the ridges and by so doing, forces the crank over. If, on the other hand, the machining of the shaft and bores of the hub are smooth and parallel and a proper allowance made for the forcing fit, with a key fitting sideways the crank would remain tight and true.

Allowances made by some engineers for press fits are: Up to and including 4 in. diameter 0.001 per inch of diameter, and above 4 in. diameter 0.0015 per inch of diameter. These values give approximately 6 tons per inch diameter. Much depends on the class of material; cast-steel crank disks fitted with steel shafts require very small allowances. From an actual test it was found that with a cast-steel crank disk fitted with a steel shaft 9 in. in diameter, where a total allowance of 0.005 in. was allowed, a pressure of 36 tons was required to force the disk home. A further test was made under similar conditions, but with an allowance of 0.0075, and it was found that a pressure of 70 tons was required.

The Insulation of Furnace Walls

Economies Obtained in Boiler Settings—Relative Conductivity of Refractories—Methods of Application

BY H. T. MATTHEW*

THE energy wasted by the loss of heat through ordinary furnace walls ranges from 3 to 15 per cent of the heat in the coal. The latter figure, however, is well beyond the limits of ordinary practice, applying only to small boilers operating at extremely low ratings. The other extreme of three per cent occurs only with the largest boilers operating at high ratings. For the average boiler under average operating conditions, this loss is at least four per cent. About seven-tenths of this amount can, on the average, be saved by proper insulation of the furnace walls. This increases the boiler over-all efficiency about three per cent, but the coal saving is greater than that. For example, suppose that the boiler efficiency is increased from 60 to 63 per cent by proper insulation of the furnace walls. Then 3/63, or nearly 5 per cent of the coal is saved. With small boilers, operating at low ratings, the percentage of coal saved may be considerably more than this.

A comparison[1] of the conductivity of average No. 1 firebrick, red brick and insulating brick[2] at various temperatures is shown in Fig. 1. It will be noted that at 1,000 deg. F., which is taken as the basis for later

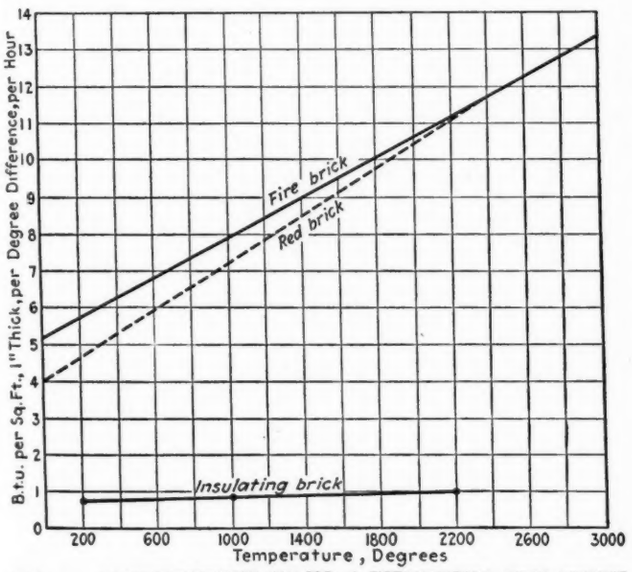


FIG. 1. CONDUCTIVITY OF NO. 1 FIREBRICK, RED BRICK AND INSULATING BRICK AT VARIOUS TEMPERATURES

comparisons of heat loss through walls, the thermal conductivity is:

For firebrick	7.9	B.t.u. per sq.ft. 1 in. thick per deg. F. difference per hour.
For red brick	7.2	
For insulating brick	0.84	

At this temperature not only has the insulating brick about one-ninth the conductivity of firebrick or red brick, but its relative insulating value increases with increasing temperature. The conductivity of insulating brick is more clearly shown in Fig. 2.

Fig. 3 is a graphic presentation of comparative heat losses through uninsulated and insulated furnace walls. Typical furnace walls of standard thickness have been selected, and the influence of one and two courses of

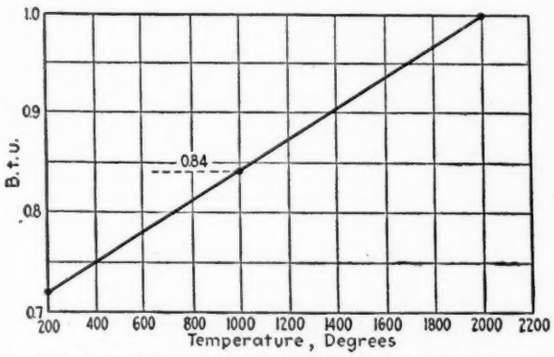


FIG. 2. CONDUCTIVITY OF INSULATING BRICK (CURVE OF FIG. 1, SHOWN TO AN ENLARGED SCALE)

insulating brick to replace fire or red brick is shown on the curve sheets adjoining each group of four walls.

In order to simplify the calculations of heat losses, which, if figured with varying constants for each inch thickness of each kind of brick, would become very complex, the constants for conductivity used are those already mentioned for 1,000 deg. F. The firebrick losses are much higher for all temperatures beyond 1,000 deg. F., but this is partly compensated for in considering red-brick conductivities. For the insulating brick the constant used seems just. It is an average for conditions met in practice, and the variation for higher or lower temperatures is but slight, the conductivity difference between 200 deg. F. and 1,700 deg. F. being only 0.23.

The curves in Fig. 3 are plotted from the formula,

$$\text{B.t.u. lost through wall per sq.ft. per hour} = \left(\begin{matrix}\text{Difference in temperature between} \\ \text{furnace and room}\end{matrix}\right) \times \left(\frac{1}{\frac{\text{Thickness of firebrick}}{7.9} + \frac{\text{Thickness of red brick}}{7.2} + \frac{\text{Thickness of insulating brick}}{0.84}}\right)$$

In this formula 7.9, 7.2 and 0.84 are the conductivities of firebrick, red brick and insulating brick, respectively. The room temperature is assumed to be 100 deg. F.

Compare two of the walls, *E* and *H*, shown in the diagram (Fig. 3) and assume an *average* inside temperature of 1,500 deg. F. as applying to the entire boiler setting. The difference in B.t.u. loss is (*E*) 622 — (*H*) 118 = 504 B.t.u. per square foot per hour. Expressed in direct ratio the heat loss through the uninsulated wall *E* is over five times as great as that through the wall *H*, which has 9 in. of insulating brick in place of 8 in. of red brick.

*Quigley Furnace Specialties Co.
[1]Curves plotted from Bureau of Standards tests.
[2]The curves and computations in this article are for "Insulbrix" insulating brick.

Applying this comparison to a furnace structure having 850 sq.ft. of wall surface insulated as shown in wall *H*, and assuming operation for 24 hours a day, 300 days in a year, the B.t.u. saving in one year as compared with wall *E* will be:

$$504 \times 850 \times 24 \times 300 = 3{,}084{,}480{,}000 \text{ B.t.u.}$$

Converted into coal (14,000 B.t.u.), the saving will be:

$$\frac{3{,}084{,}480{,}000}{14{,}000 \times 2{,}000} = 110 \text{ tons coal.}$$

Expressed in amount of fuel oil, the saving would be 22,000 gal. per year.

As another illustration, refer to the side-wall sections shown in *B* and *C*. The insulating course shown, if considered as a substitute for the same thickness of firebrick, will at 1,500 deg. F. inside temperature, effect a saving of 310 B.t.u. per square foot per hour. It reduces the heat loss about 63 per cent.

This represents the saving by insulation of walls only. Additional savings are obtainable by use of insulating brick over drums and arches and by the use of insulating concrete. For surfaces where insulation in brick form cannot be applied, such as heads of horizontal drums, special shapes are used or a plastic mixture of the same material as the brick may be troweled on, using metal reinforcement in the form of wire mesh if necessary.

In some furnace structures it becomes necessary to sacrifice efficiency and dissipate the heat through the furnace walls in order to prevent failure of the firebrick so as to reduce maintenance costs. Open-hearth furnaces and glass-melting furnaces are notable examples where the use of insulating brick would be apt to cause quick failure of the firebrick lining unless used with discretion.

Under certain firing conditions this also may apply in some boiler furnaces, but only to the high-heat zone of the combustion chamber.[3] Where the inside temperature is 2,400 deg. F. or less, insulation can be built

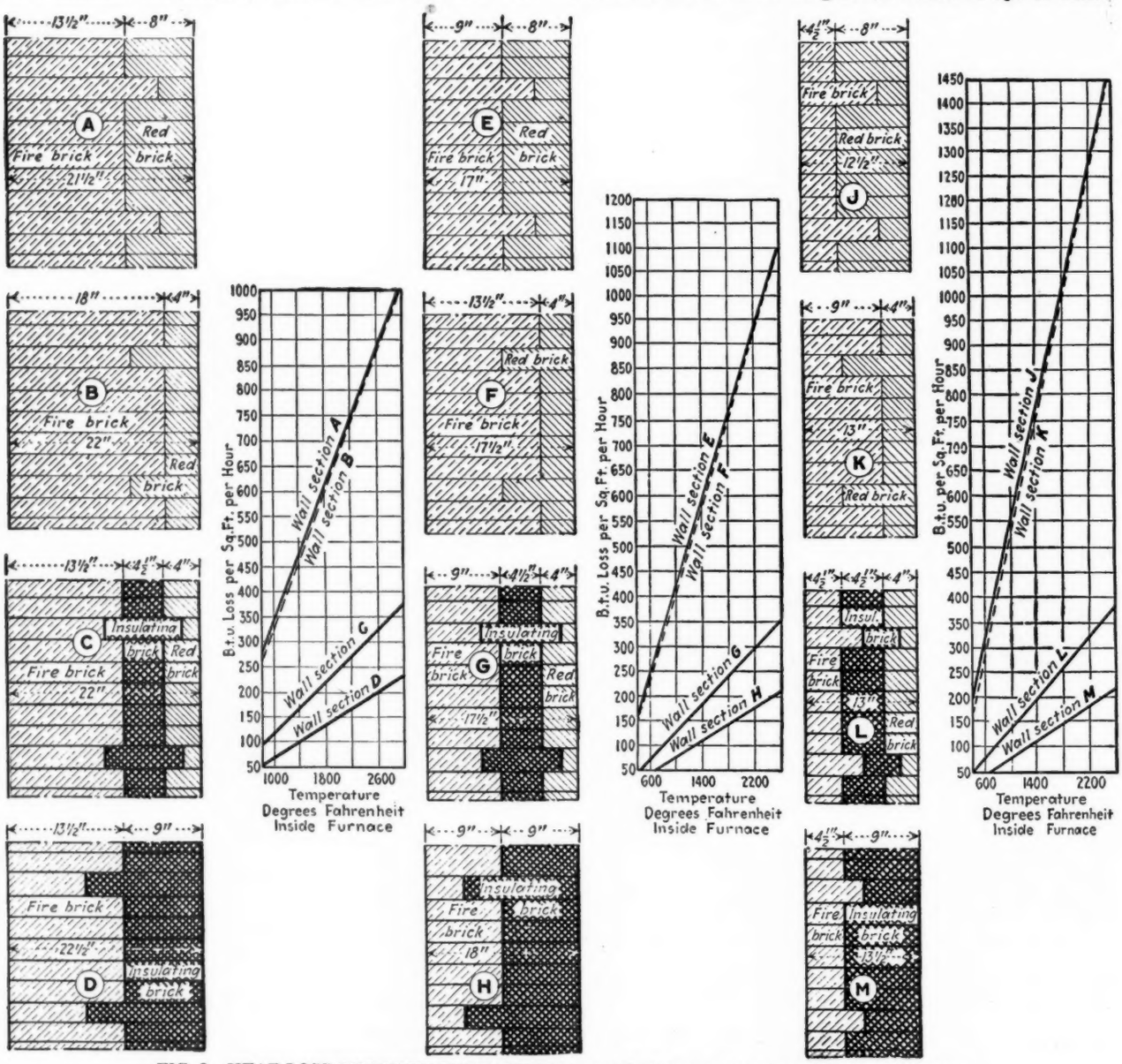


FIG. 3. HEAT LOSS THROUGH FURNACE WALLS OF VARIED CONSTRUCTION, SHOWING A LARGE SAVING FOR INSULATED WA

[3]Proceedings Engineers Society of Western Pennsylvania, April, 1921.

in the walls as close as 9 in. from the inside face of the wall without detriment to the refractory brickwork provided calcined insulation of suitable high heat resisting quality is used.

A survey of the temperature drop through any boiler setting will show that the high-heat zone of the combustion chamber is of very limited area. In cases of extreme temperatures special refractories used in this zone would permit insulation to be applied throughout the setting without damage to the lining.

The tendency in the past has been to avoid placing insulation near high-heat zones in the walls not only for fear of failure of the firebrick, but on account of the shrinkage of the insulation itself. Insulating brick are now made, however, that have shown by test no shrinkage under pressure of 40 lb. per sq.in. at 1,900 deg. F. and but slight shrinkage at 2,000 deg. F.

In boiler furnaces with insulated walls, overloads are more uniformly maintained and with the use of less fuel. In all types of boilers that are supported by a steel structure and are not dependent on the walls for support, thinner walls can be used, the cost of construction reduced and space saved when insulation in rugged brick form is built in as part of the wall structure including the outside course and not used merely as a division course or veneer.

The practice of wetting the brick before laying should not be followed with insulating bricks. Owing to their porosity they absorb too much moisture if dipped in water, and this moisture would have to be driven out through the walls. A non-absorbent batter of cement made of the same base material as the bricks themselves is used. The bricks are dipped in this batter and laid up with a thin push or rub joint. Their standard size enables them to be laid up to conform with the firebrick linings with the usual four courses of stretchers and one header.

The insulation of boiler furnaces to decrease heat flow from the equipment has the following advantages, which may be classed as major or minor depending upon type of plant, cost of fuel, location of equipment and method of firing. These are: Saving in fuel, saving in brick work, increase in capacity, better control of temperatures, freedom from leaky settings, rapid response to overload, reduced boiler-room temperature. Considering the first item only, it is significant that it has been found advisable to insulate boiler walls at mine-mouth plants where fuel is cheapest.

Most boiler-room losses are kept down only by everlasting vigilance, but insulation, once installed, functions constantly without being watched. For this reason the savings shown by tests or computations are maintained in daily operation without the slightest thought or attention on the part of the operating force.

Central station companies, during the present coal emergency, are storing large stocks of coal to depths of as much as 40 ft. The usual maximum depth is from 8 to 10 ft. The Rockingham County Light and Power Co., of Portsmouth, N. H., guards against the danger of spontaneous combustion from overheating by running iron pipes from top to bottom of its coal pocket at the Daniel Street generating station. Through these pipes, thermometers attached to strong cords may be raised and lowered. Thus the temperature of the coal at various depths may be ascertained, and when a hot spot occurs, coal may be drawn from the nearest chute.

The Value of Our Magazines

By Arthur D. Palmer

There are scores of engineers today who load up their desks with technical papers but get little value out of them. They usually look at the pictures, read the headlines of articles, give a quick look at the ads and then file the magazine away for some future time—a time that never comes.

Not long ago I had occasion to drop into a fair-sized local plant, and I found the chief in trouble. A problem had come up in indicating; he had been unable to work out the problem himself, and did not seem to be able to find anyone else that could. Lying on the chief's desk were some unopened copies of *Power;* I opened them and showed the chief an article which plainly explained the solution of the problem he was stumped with. Here was a problem that my friend had spent sleepless nights over, with the explanation lying on the desk before him.

Personally, I have a little system of my own in reading and looking over my magazines, whereby I think I get full value out of every copy that comes to my desk. My system is as follows: I take each magazine that comes to me and go through it with a plan in view. Some magazines I never clip. I have the volumes bound once a year, and, with the index furnished, have no trouble in finding anything that is in these papers. In looking through the magazine, I first go over the index and mark those articles that I think call for special attention. I then go through the ads, and where I note something new that interests me or that may come up in my work, I clip this ad out and later send for such data as I want. In this way I keep up with any improvements in the manufacturing field, and also keep my data on equipment up to date.

After looking over the paper in general, I turn to the foreword page, where I always find something good in the line of advice. With reference to the general-articles section of technical papers, I would call attention to a recent issue of *Power*. On page 1007 there is a fine article on "Selection and Application of Motors." All of us in these days when the handling of electrical equipment is about half of our work should know something about the proper selection of a motor for our particular job. In reading over an article of this kind I take notes of important formulas, tables, etc., and file them in a loose-leaf book. In this way the article is condensed somewhat but still retains its full value. Again, on page 1011 is an article on the "Absolute Pressure Gage." If anyone had asked me to make a gage of this kind I should have had to look the matter up, and I frankly do not know just where I would have looked for this information. By making a small sketch of the device and a few explanatory notes, I have something that I can always refer to.

On page 1016 there is a table of injector troubles that would be worth its weight in gold to a man having trouble with injectors.

With these magazines that I pass on to fellow engineers, I try to get all I can out of them, and what I save I condense, taking what is essential to a ready understanding of the device or matter reported. I have notes and clippings that have saved me hours of study.

I have also a data book with 1,500 power-plant devices, with a brief description of the care and operation of each and an illustration showing it in section.

The Heat Value of Corn

By WILLIAM L. DeBAUFRE
Mechanical Engineering Department, University of Nebraska

WHEN the market price of corn goes down or when the price of coal suffers a marked change in the reverse direction, there always arises in the corn-producing states the question of whether it is not more economical to burn corn than to purchase coal for fuel. In order to answer this question, there have been conducted a series of tests by the mechanical engineering department of the University of Nebraska, to determine the heat value of corn.

Four varieties of corn—Hogue's Yellow Dent, University No. 3, Blair White and Nebraska White Prize—were tested as husked from the field, without selection, in the fall of 1921. These four varieties are representative of the different types of grain and cobs, both yellow and white. Bulk samples of each of the four varieties were weighed as husked, then run through the corn sheller and the grain and cobs weighed separately.

The percentage of moisture in both grain and cobs of each variety was next determined by weighing before and after drying in an oven at constant temperature. Then samples of each variety were finely ground, in preparation for the heat-value determinations, which were made in a bomb calorimeter.

IN THE Argentine Republic during the war, corn was successfully burned under boilers as a substitute for coal, and now in some of our corn-producing states this same substitute is being considered. The University of Nebraska has determined the heat value of the principal varieties of corn in order to find out just how high the price of coal must go before the change from coal to corn becomes a profitable one.

Under the experimental conditions the heat values were obtained in a calorimeter in which the products of combustion were cooled to room temperature, which resulted in the condensation within the calorimeter of the water vapor formed during combustion. While it has become customary to base a comparison of the heat value of fuels upon such calorimeter determinations, the results are not considered fair when much water vapor is formed during combustion. The reason is that under ordinary furnace conditions the gases escape at such high temperature that the water vapor is not condensed, and consequently its latent heat (approximately 1,000 B.t.u. per lb.) is not recovered, as it is in the calorimeter. Therefore, the "lower" heat value of corn, obtained by subtracting the latent heat of the water content from the calorimeter value, is the practical value to be considered.

TABLE I. HEAT VALUES OF CORN AS AFFECTED BY MOISTURE CONTENT

Moisture, per Cent	Lower Heat Value B.t.u. per Pound
0	7,578
5	7,149
10	6,720
15	6,291
20	5,862
25	5,434
30	5,005
35	4,576
40	4,147
45	3,718
50	3,289

TABLE II. RELATIVE PRICES OF COAL AND CORN FOR EQUAL HEAT VALUES

Price of Pittsburgh, Kansas, Coal per Ton of 2,000 Lb.	Price of Corn on Cob per Bushel of 70 Lb.	Price of Shelled Corn per Bushel of 56 Lb.
$10.00	$0.20	$0.16
12.00	0.24	0.19
14.00	0.28	0.22
16.00	0.32	0.26
18.00	0.36	0.29
20.00	0.40	0.32

The results of the investigation show that practically no difference exists between the heat values of the four varieties of corn, and that the heat content of the cobs per pound is practically the same as that of the grain. The average higher heat value of dry corn was 8,159 B.t.u. per lb., and of dry cobs, 8,101 B.t.u. per lb. The average lower heat values were 7,579 and 7,577 B.t.u. per lb., respectively.

There is a variation in the heat value, however, which depends upon the percentage of moisture the corn contains. At the time of maturity the grain and cobs may contain over 50 per cent of water, the cobs containing somewhat more moisture than the grain. When very dry, the grain and cobs may contain less than 10 per cent of water. The effective (lower) heat values for various percentages of moisture content are given in Table I.

The chief value of the investigation lies in the possibility of comparison between coal and corn as boiler fuels. For fully cured corn containing, say, 10 per cent of moisture, the effective (lower) heat value is approximately 6,700 B.t.u. per lb. A corresponding value for Pittsburg, Kan., coal is 11,800 B.t.u. per lb. Consequently, the heat value of 50 bushels of corn on the cob or of 63 bushels of shelled corn is about equivalent to that of one ton of bituminous coal. With coal at ten dollars a ton the price of corn on the cob must be less than 20 cents a bushel of 70 pounds, and of shelled corn less than 16 cents a bushel of 56 pounds, to make it more economical to burn corn than to purchase coal. This comparison does not include any allowance for the cost of handling either fuel. With coal costing more or less, the price of corn would vary in proportion, as given in Table II. Also, for coal of better or poorer quality the price of corn would vary accordingly.

It is interesting to note that a given amount of corn will produce more useful heat after storage than before, even though less weight of material is present, owing to evaporation of moisture during storage. Thus, a hundred bushels of corn, as husked from the field and containing, say, 25 per cent of moisture, would produce about 38 million B.t.u. After storage for sufficient time to reduce the moisture to about 10 per cent, there would be present only 83.3 bushels of corn, but it would produce over 39 million B.t.u. The reason is that moisture not only contributes nothing to the heat content of corn, but really reduces the available heat by the amount required to evaporate the moisture. Thus, while corn shrinks in financial value during storage by reason of loss in weight, this loss of moisture increases its value for heating purposes.

EDITORIALS

High-Pressure Piping

THERE is an increasing number of large power plants in which steam pressures over 250 pounds will be employed. Such pressures require close attention to the design of valves, pipe fittings and flanges. The highest A. S. M. E. standards for steam piping at present are for 250 pounds working pressure. Fittings and flanges made according to this standard have not been considered strong enough for the higher pressures. Last year's report of the Prime Movers Committee of the National Electrical Light Association called attention to several designs of pipe flanges and joints that have been proposed. Since that time several others have been designed. Some manufacturers have adopted the bolt circle, bolt size and outside flange diameters of the 800-pound hydraulic A. S. M. E. standards and are using these for the higher steam pressures. Other designers have slightly modified the dimensions of these 800-pound hydraulic standards. Another design of a well-known high-pressure joint departs considerably from previous standards.

It will be obvious that this mutiplicity of flange sizes, bolt circles and patterns will ultimately lead only to confusion and will make standardization more difficult and more expensive at some later date. Surely, our pipe manufacturers and power-plant engineers have sufficient data on hand to enable them to fix certain definite standards for flanges, bolts, bolt circles, etc., for steam pressures up to, say, 500 pounds. Under the sponsorship of the A. S. M. E. the American Engineering Standards Committee has undertaken the work of developing standards for pressures over 250 pounds, but up to the present progress has been slow. Meanwhile the British have announced their decision to standardize for 250, 350 and 450 pounds.

Data are lacking on the operating performance of the various kinds of joints, gaskets and valve materials used with high pressures. In many cases these have not been in service long enough to permit a fair estimate of their useful life. However, the profession as a whole and power-plant operators in particular will gain from a frank statement regarding experience and particularly regarding failures of these materials under high steam pressures and high temperatures.

Can Corrosion Occur Without Acid?

TO THE average engineer iron is iron and water is merely water, until he starts to study the subject of corrosion. Then he finds that either of these words may stand for a hundred different things, since both iron and water ordinarily contain many impurities which have a marked effect on their properties. In fact, the theory of corrosion or "rusting" is so complicated that experts still disagree on some of the fundamental points.

A case at hand is that of acid in the water. All agree that rusting is caused by dissolved oxygen, meaning that without this oxygen most natural waters are practically harmless to iron. But is the presence of oxygen as sure to cause rusting as its absence is to prevent it? Here the experts disagree. Some of the best American authorities say that corrosion is bound to occur wherever water, iron and oxygen come together, while a prominent English expert claims that there must be a little acid present to start the corrosion, which he admits is maintained by the oxygen. In the main, the point seems to be merely of academic interest because practically any water outside of a chemical laboratory contains enough acid to start the action. It appears that the dissolved CO_2 is alone quite sufficient for the purpose in the majority of cases.

Once started, the amount of corrosion seems to be limited only by the amount of free oxygen present, but the rate at which corrosion occurs is apparently affected to a large extent by the presence of various impurities in the water and in the metal. The relations, as already intimated, are far from simple. For example, most experts have stopped making blanket claims that iron pipe is more resistant than steel, or the reverse. They have found that small variations in composition or mechanical treatment make a large difference. It is generally agreed that, other things being equal, the material that is most homogeneous and free from strains will be least affected by corrosion.

Out of this maze of facts and theories the operating engineer may pick one principle as being fairly well established and of considerable practical importance. It is that dissolved oxygen (ordinarily obtained from the air) is practically certain, under power-plant conditions, to cause corrosion of iron or steel surfaces exposed to the water, and that while such precautions as a careful selection of materials may greatly retard corrosion, the oxygen must be removed if corrosion is to be prevented.

The Value of Exhaust Steam

IT IS an axiom in power-plant engineering that no steam should be put into a condenser when there is use for heat at temperatures that the exhaust steam can furnish, even if it involves carrying a considerable back pressure on enough of the apparatus to furnish such high-pressure exhaust as can be usefully consumed.

This is true from a heat-unit or fuel point of view, at least. Of course the cost of the necessary apparatus comes into the over-all economy.

To run steam through an engine or a turbine into a condenser and then make more steam for heating or manufacturing processes is like taking water from the mill pond under the full head for washing and other purposes. If you are short of water or have to pay for it, it may be worth while to put in a turbine that would pass enough for the process and discharge it at a level that would allow it to flow to the work. Some of the head on the auxiliary turbine would be sacrificed, but the power of the falling water from the level of the mill pond to that of its higher discharge would be saved.

The idea is too prevalent that it does not cost much to make low-pressure steam. There are, in a pound of dry saturated steam 200 pounds pressure, absolute, 1,198.1 B.t.u. There are, in a pound of dry saturated steam of atmospheric pressure, 1,150.4 B.t.u. It takes practically as much boiler and labor and repairs and overhead to make one as the other. It is better to make it all at the high pressure, expand it in an engine or a pump or turbine to the desired pressure and get the power obtainable by its fall in temperature.

We know of a factory that is burning over a hundred thousand pounds of coal a day making steam at over one hundred pounds pressure, reducing it to thirty-five pounds and using it in processes. If they would pass it through the simplest kind of turbine instead of through reducing valves, they could make for practically nothing all the power that they are now purchasing.

With a compound engine steam may be bled from the receiver for heating and process work. Years ago Charles T. Main ran the steam through a compound engine backward, putting the high-pressure steam into the low-pressure cylinder and connecting the smaller cylinder to the condenser because the mill took so much out of the receiver that there was only enough left to run the high-pressure side.

There is a prejudice against exhaust steam on the part of dyers and department foremen—not on account of its temperature, for the temperature of the high-pressure steam drops the instant it passes the control valve, but because it does not work fast enough. They do not get so much of it in at the lesser pressure in the same time. This is only a question of volumes. Give it pipe enough to get there under the lesser head.

The objection of oil in the exhaust is answered by the turbine, the exhaust of which is free from oil, and the turbine can be bled at any stage, giving off enough exhaust at any desired pressure to supply the needs of the moment and allowing that which is not required to pass on through the lower stages to the condenser.

Some Coal Facts

IN MANY industrial plants the stocks of coal are getting low, and in certain sections of the country executives are beginning to face the alternative of curtailed production or early shutdown. Other sections have no immediate cause for alarm. However, those who may cherish the opinion that an ample supply of bituminous coal will soon be available would do well to ponder upon the following facts:

In the first place the strike is not yet settled and there are no indications as to just when it will be.

After the strike has been settled, it will probably take a month, including the time the coal is in transit, to meet the demands.

The demand is normally about eight million tons a week. Only half this amount is at present being produced in the non-union fields. This is being supplemented by a limited amount of English coal.

On April first there was 67 million tons in storage at the plants of consumers, about 10 million tons in transit and probably another million at the mines, making in all about 78 million tons. Since then there has been mined 105 million tons. This makes a total of 183 million tons, of which more than 150 million tons has been used, leaving about 33 million tons, or on an average of 30 days' supply, counting that in transit.

But it must be remembered that this is an average for the whole country and includes the comparatively large stocks of many utilities and large industries. Moreover, industries in New England and along the Atlantic Seaboard are fairly well fixed. They have been receiving coal from the West Virginia fields.

In the Northwest and Middle West the situation is serious, as concerns both the railroads and the industries, and Eastern coal is now being diverted there. The effect of this may be felt on the Atlantic Seaboard.

The anthracite situation is even more serious, although this concerns the domestic consumer more than the industrial, as those power plants of the East that use anthracite can, as an emergency measure, use bituminous coal.

There is very little over-capacity in the anthracite mines, and normally it takes twelve months' production to meet the seven months' active demand. With over four months' production stopped and a limited amount in storage when the strike began, it is evident that great difficulty would be experienced in catching up with the demand even in the event of early settlement.

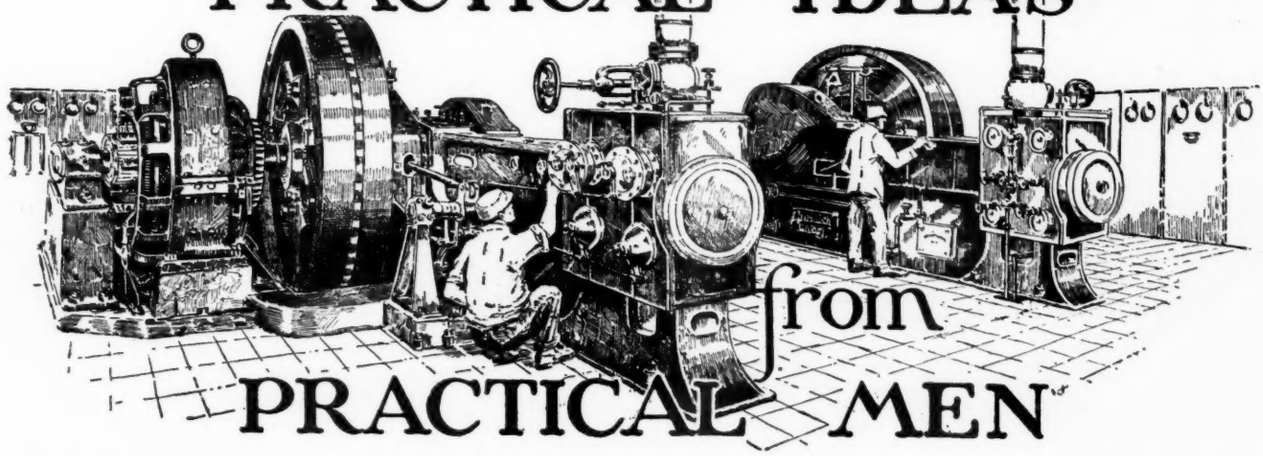
From the foregoing it is apparent that the situation is more or less serious, depending upon the locality; but that there is genuine need for attention to fuel economies by power-plant men everywhere cannot be too strongly urged. These may take the form of alterations in furnaces and grates to burn other grades of coal, rearrangement of firing schedules, or in some cases manufacturing schedules, closer attention to combustion, etc. Whatever the form, it will require the closest co-operation between the executive and the operating engineer in order to pull through the emergency.

Obtaining an over-all thermal efficiency of twenty per cent or better in large power stations is something that has been talked about considerably, but the figures show that if many of them are getting an average of seventeen per cent they are doing about their best, even when burning a high-grade coal. Some of the big plants run on an average as high as twenty-five thousand to thirty thousand heat units per kilowatt-hour, or an over-all thermal efficiency of twelve per cent or less. It is not how many heat units that are required to produce a unit of power under the best conditions in the plant, but what the total kilowatt-hours for one year divided into the total heat units show, that tell the story.

Mere man, who can select a certain style of suit and stick to it—the style and frequently the suit also—for years, is prone to thank his lucky stars that he was not born a woman. While patting himself on the back over his escape from being a feminine slave of fashion, he might do well to see whether fashion has not fooled him after all. For, as a prominent engineer observed only the other day, there are styles or fashions in engineering as well as in clothes, and often they are followed almost as blindly.

Every now and then someone conceives of a "power-multiplying" device—something with which ten horsepower can be made do the work of twenty-five or more through some complicated arrangement of levers, gears, pulleys, etc. Such ideas, of course, arise from a misunderstanding of the laws of mechanics. People in all walks of life make the same mistake; they try to get something for nothing—a thing that can't be done in mechanics, in business, nor in any phase of life in general.

PRACTICAL IDEAS from PRACTICAL MEN



Eyes Should Be Protected from Intense Heat and Light

Ten years ago, very little thought was given to protecting the eyes from injurious light radiations. Since then we have come to realize that there are many sources of such radiations to which the eye should not be exposed. Witness, for instance, the precautions now usually taken to shield from the eye the light of the arc-welding machines used in repairing railway tracks.

Coming closer home to the power-plant operator, we find that the furnace fuel-bed is a potential source of danger, the extent of which is scarcely appreciated. Before we decide what factors in different plants may affect the danger of light emitted from a furnace, a brief consideration of light waves may be helpful.

We are all familiar with the method of separating, through a prism, the colors that blend to make white light—the violet, which are the light rays of short wave-length, at one end, and on through the blue, green, yellow and orange to the red, the rays of greater wave-length at the other end. Beyond each end of this visible spectrum lie the invisible rays that are injurious to the eye. Next to the violet come the shorter wave-length ultra-violet rays; and at the other end come the infra-red, or heat rays, which have a much greater wave-length than the visible red rays. The ultra-violet light rays can penetrate clear through the eye and are very injurious, sometimes causing severe cases of conjunctivitis (an inflammation of the membrane covering the eyelids and part of the eyeball). This would be the result of long exposure to electric arc rays. However, it is still a question whether a furnace produces enough such rays to injure the eye. On the other hand, it is quite certain that the infra-red or heat rays emitted, have a destructive effect on the eyesight because of their tendency to produce "burns." This is purely a thermal action, and its effect is felt whenever we open the furnace door to examine the fire.

There is another source of severe injury to the eye, and that is from the glare. The hotter the fire in the furnace, the more nearly white the fuel bed appears. If we attempt to watch the fire for any length of time, nature tries to cut down the amount of intense light entering the eye by contracting the pupil. This contraction, if continued, strains the muscles of the eyes abnormally and produces sharp pain and possibly headache. All these ill effects, whether from the glare of the intense light or from the heat rays, are cumulative. In the small plant, where hand-firing and natural draft are the rule, and where the boilers are seldom operated above 75 to 100 per cent of rating, the fuel-bed temperatures are reasonably moderate, and the injurious effect of the glare and of the heat rays is not so pronounced.

In larger plants we find a different condition. More boilers are stoker-fired; many have artificial draft; and the boilers are operated at higher rating. Then we come to the large central stations, with large stoker-fired boilers continuously operated at 150 to 300 per cent rating, using a combination force and induced draft system. Under such conditions, the injurious effect of the glare and of the heat rays is very much greater than with low-temperature fires. Although exposure takes place only when the fire is inspected through the side-wall doors or when clinkers are dislodged, etc., yet the natural tendency of the fireman is to cut these operations as short as possible to avoid excessive eye-strain. He may not realize this tendency to slight his work, or the cause of it, but it exists nevertheless.

In plants where furnaces are operated at high rating, each fireman should be provided with his own pair of comfortable and well-ventilated goggles, to be worn whenever he cleans the fires, and he should thoroughly understand why you insist on his wearing them. Beside each furnace door should be hung a convenient wooden frame holding a plate of the proper glass to be used by anyone examining the fires.

A consideration of the factors to be guarded against will make it obvious that the ideal glass would be one that would shut out (absorb) entirely the ultra-violet and the heat rays, and would transmit only enough of the visible rays to prevent irritation and injury to the eye. In other words, it should absorb the dangerous invisible rays and eliminate glare.

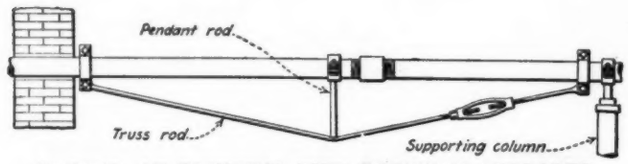
The Bureau of Standards has tested scores of typical samples of glasses, including many widely advertised commercial protective glasses, and has found that by far the best protection is afforded by such glasses as "Signal Green," "Ferrous Sage-Green" and similar glass known as "Noviweld."

This matter of injury to the eyesight from fuel-bed radiations is not a theory or an idle dream, and power-plant operators agree that corrective measures will prove to be a sound investment. W. J. RISLEY, JR.

Philadelphia, Pa.

Truss Support for Water Pipe

The 10-in. pipe that conveys the water from the sump beneath a cooling tower located on the roof of a manufacturing building, to an ammonia condenser on the roof of a power house, extends above a 25-ft. driveway between the two buildings. Above the power house it is supported on columns made of 3-in. pipe. The distance from the wall of the manufacturing building to the first supporting column on the power-house roof is about thirty feet. This was considered too great a



METHOD OF TRUSSING PIPE BETWEEN SUPPORTS

span to be left unsupported, particularly since the pipe is joined with a coupling at about the middle of the span. It was decided, therefore, to truss up this portion of the pipe as shown in the sketch.

A ¾ x 3-in. collar, made in halves, with the lower half drilled and tapped to receive a 1¼-in. pendant rod about 20 in. long, was clamped to the pipe at the middle of the unsupported span. A ¾ x 3-in. collar was also clamped to the pipe at each end of the span. A 1-in. truss rod, containing a turnbuckle and with eyes turned on at each end for bolting to the end clamps, was then carried across the end of the pendant from the middle clamp—a groove having been made in the end of the pendant for the truss rod to ride in. It then remained simply to tighten up with the turnbuckle.

When steam or hot-water pipes are trussed in this manner, the truss rods should not be drawn up until the pipes are heated to the highest temperature they are likely to sustain in service. If the truss rod is drawn up while the pipe is cold, the expansion of the pipe, when heated, will put too great a stress on the rod and may cause the pipe to buckle up at the middle.

St. Louis, Mo. A. J. DIXON.

Live Steam or Exhaust for Process Work

I would like to have opinions and facts if possible from the readers of *Power* regarding the following problems:

In a certain mill new generating units are under consideration. Exhaust steam at 10 to 15 lb. in excess of that obtained from units when running non-condensing, is in demand for heating and drying. Processes are so scattered that long lines of 8- or 10-in. size would be needed to distribute the low-pressure steam, necessitating several 500- to 700-ft. lines, with makeup introduced at various points. Water at a 5-ft. head is available for condensing purposes, so the question arises as to the advisability of running non-condensing with covered pipe lines, or condensing and using live steam for process and heating requirements.

There has been little published on the steam rates and efficiencies of the turbine, unaflow and four-valve engine units of 500 to 750 kva. capacity operating on variable load and at a back pressure of 10 to 15 lb. gage. As this is a live subject at the present time, some discussion will no doubt be of value.

Paterson, N. J. C. T. ZURINGLI.

Reconnecting a Two-Phase Stator

A two-horsepower two-phase squirrel-cage induction-motor's stator was to be stripped for rewinding. The coil throw, turns per coil, size of wire, total number of coils and number of coils per group were noted as follows, with a diagram of connection as shown in Fig. 1: Coils, 36; slots, 36; coil pitch, 1 and 8; turns per coil, 40; wire size, No. 19, single-cotton covered enamel; groups, 5-4-5-5-4-4-5-4.

When the winder was putting in the phase insulation the grouping was again checked and found to be incorrect, as shown by the simplified diagram, Fig. 1. Phase *A* had a total of 19 coils and *B* a total of 17 coils. This put an unequal voltage strain on the phases and also on each of the series of 2 groups. To correct this condition the grouping was changed, as in Fig. 2.

The voltage across each coil when properly connected is 220 ÷ 9 = 24.4 volts. In the original winding 2 series had 9 coils each, one had 8 and the other 10 coils. The series of 8 would have an impressed voltage of 220 ÷ 8 = 27.5 across each coil or an increase of 13 per cent, which would cause this group of coils to take an excessive current and heat.

The series of 10 coils had an impressed voltage of 220 ÷ 10 = 22.0. As this value is approximately equal to the counter-electromotive force of these coils, there would be practically no current passing through them,

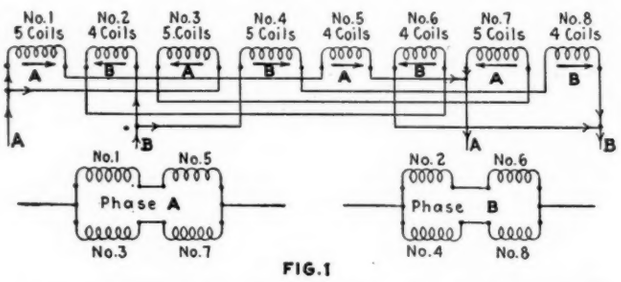


FIG. 1

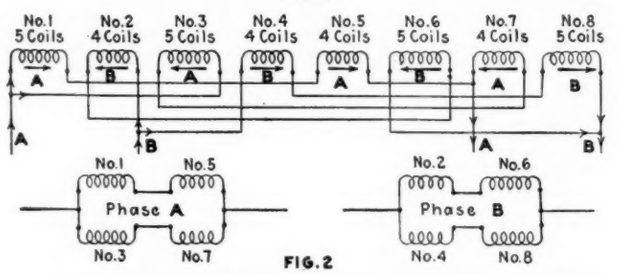


FIG. 2

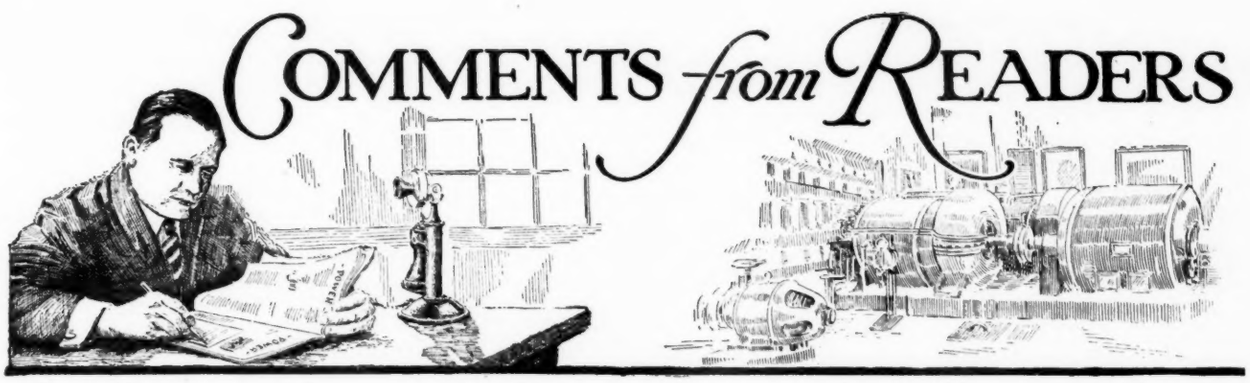
FIGS. 1 AND 2. INCORRECT AND CORRECT WAY OF CONNECTING WINDINGS

hence they would do no work. This in turn would cause the other series of 9 coils in phase *A* to do all of the work for that phase. With this unbalanced condition, it is not difficult to understand why the original winding burnt up.

A. H. BRAME.

Newark, N. J.

In the Water Street station of the Toledo Edison Co., feed water is subjected to the continuous treating process. This is the method employed in plants where jet or barometric condensers are used. The necessary apparatus includes a feed-water heater, a sludge or settling tank, two or more filters and a chemical feeding device. The cost of such treatment at the Water Street plant is 9.8 cents per thousand gallons.



Effects of Boiler Efficiency on Amount of Fuel Burned

Referring to the article in the June 27 issue, by J. David Wright, on the effects of boiler efficiency on the amount of coal burned, I was recently called in to investigate the condition of a small electric light, power and water plant that had been operating at a loss of about 22 per cent for six years.

Upon investigation, the boiler efficiency was found to be only 38 per cent. Natural gas with a calorific value of 900 B.t.u. per cu.ft. was used for fuel, and the cost of fuel amounted to $416 per month.

After some alterations had been made in the furnace and several steam leaks stopped, the boiler efficiency was increased to 66 per cent. This reduced the fuel bill to $216 per month. The generating equipment was gone over and repairs were made where necessary. This, together with a reduction in transmission losses, brought the fuel cost down to $187 per month on the same kilowatt output, and in less than three months the plant was paying over 8 per cent on the investment, overhead charges included. There are undoubtedly many other small plants that could be made to show a revenue if the efficiency were maintained somewhere near normal.

Ponca City, Okla. V. K. STANLEY.

Know Your Costs

We read, with a great deal of interest, your editorial in the June 20 issue, under the heading of "Know Your Costs."

The discussion of the specialized sales effort of the central stations is, indeed, interesting and timely. It is a fact that hundreds of isolated plants have been shut down simply because their owners did not know what their plants were doing, or were capable of doing, and their operating engineers could not tell them.

The average business man is tremendously influenced by the bigness of things. If a thing is big, he thinks it must be inherently better and more economical than a small thing. He assumes that because the central station has a large plant he must, of necessity, be able to purchase his electricity cheaper than he can generate it. He does not realize that the central station has a loss in distribution of from 10 to 30 per cent of the energy that is generated, which cannot be delivered to the customers' meters. Nor does he realize that the investment in the central-station property, including the generating plant and distributing system, is larger per kilowatt of capacity than the majority of isolated plants, and the fixed charges on the capital investment, of course, are passed on to the consumer. In many of the rate schedules this capital charge is set up as a separate item and is commonly referred to as "Demand Charge," or "Service Charge."

One frequently hears big business men say that they purchase their power because they do not have to carry any investment in power plant. This, of course, is absurd, and the purchaser of power usually pays a higher investment burden on plant than if he had his own isolated plant. The manufacturing costs, or running part of the power bill usually referred to in modern rates as the "Energy Charge," may be lower than they would be in operating his own plant, but the fixed and running expenses may, and will, in many instances, exceed the costs in a well-operated isolated plant.

As to power costs, the executives in many of the industrial plants have their judgment badly warped in discussing the cost per kilowatt-hour. In this latitude the heating of the buildings and other uses for steam at low pressure, are so interwoven with the cost of generating electricity that it is almost impossible, in the average plant, to separate accurately the cost of heat from the cost of power and light. The real answer to many of these situations is not the cost per kilowatt-hour, but in the combined annual costs of heat, light and power, regardless of whether the power is purchased or generated in the isolated plant.

It is amusing, in some of the large buildings and particularly in modern hotels, to listen to the stress that is laid on the matter of generating electricity. As a matter of fact, in many of these situations the size and the cost of the boiler plant is not influenced in the slightest degree whether electricity is generated in the building or not. The real thing is the boiler plant, which is required in most buildings regardless of where the electricity comes from, and this leads to the proper segregation of the investment required for heat and that required for light and power.

There are large numbers of buildings, and industrial establishments where the power and lighting load would be completely submerged in the heating for the major part of the year, and obviously, in situations like these the cost per kilowatt-hour for the electricity means little unless proper credit is given for the byproduct, heat.

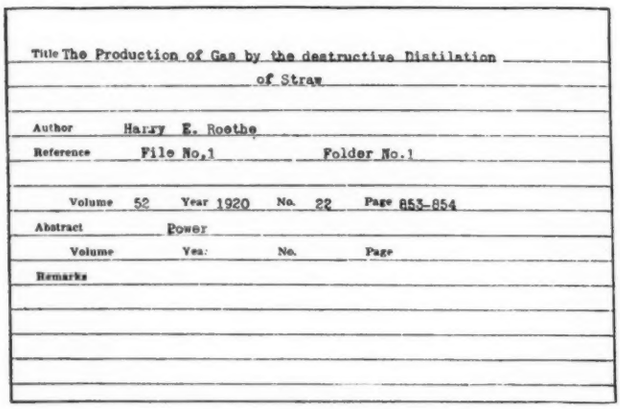
We do not wish to convey the idea that there is not an enormous field for the central station in which to market its product, but its product is to be sold on a basis that will save money for the fellow who buys it and not on a basis of fooling the purchaser with the figures.

EGBERT DOUGLAS,
Cahill & Douglas, Engineers.

Milwaukee, Wis.

Filing Information

I read with interest in the June 27 issue the foreword on filing information. In my opinion it would be wrong to back every reading page up with advertising, as it is very easy to index articles one wishes to refer to later on cards. The cut here illustrated shows an index card, 4 x 6 in., which I have been using for many years and which has proved convenient and satisfactory.


Title The Production of Gas by the destructive Distillation of Straw

Author Harry E. Roethe

Reference File No.1 Folder No.1

Volume 52 Year 1920 No. 22 Page 853-854

Abstract Power

Volume Year No. Page

Remarks

CARD USED FOR INDEXING ARTICLES

Austin, Pa. JOHN A. KAGERHUBER, M. E.

Detection of Broken Staybolts

In the July 11 issue my attention was attracted by the answer given to the inquiry regarding the detection of broken staybolts because a number of years ago, when personally inspecting boilers I prided myself upon my ability to detect a broken staybolt by the hammer test.

This test depends upon the vibration of the sheet for the detection of broken bolts. If a bolt is broken, the furnace sheet immediately adjacent to it will vibrate when the bolt head is struck a sharp blow by an inspection hammer. This vibration can be detected readily by placing the index finger and second finger of the left hand on each side of the bolt heads as they are tapped. This test, of course, is most effective when the boiler is empty, because with the boiler full of water the vibration is deadened to some extent.

From time to time, hammer-testing of boilers has been criticised, and some engineers whose opinions cannot be ignored have suggested that the detection of broken bolts, cracked sheets, etc., is impossible by a mere hammer test. Those of us who have had considerable experience along this line, of course, do not agree with this attitude, and for some authentic report or ruling on this I would call attention to the following, Rules 21 and 22, from the 1919 Edition of the Laws, Rules and Instructions for Inspection and Testing of Locomotives, Interstate Commerce Commission, Division of Locomotive Inspection:

21. Time of testing rigid bolts—All staybolts shall be tested at least once each month. Staybolts shall also be tested immediately after every hydrostatic test.

22. Method of testing rigid bolts—The inspector must tap each bolt and determine the broken bolts from the sound or the vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there must be not less than 50 pounds pressure on the boiler. Should the boiler not be under pressure, the test may be made after draining all water from the boiler, in which case the vibration of the sheet will indicate any unsoundness. The latter test is preferable.

DAN L. ROYER, Chief Engineer,
Ocean Accident & Guarantee Corp.
New York City.

Oil-Fired Boilers at Amoskeag

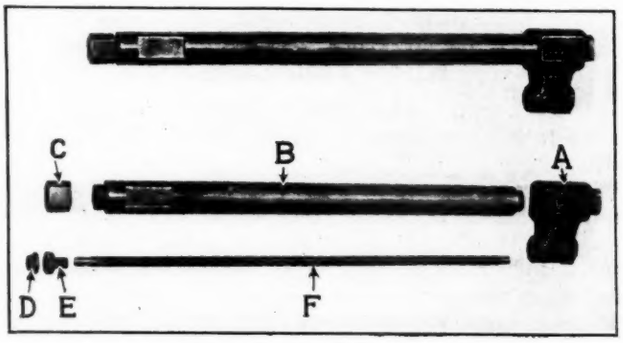
We have read with much interest an article appearing in the June 13 issue, entitled "Oil Firing Sixty-four Boilers at Amoskeag." This article clearly illustrates and describes the application of our wide-range system, as applied to a type of vertical boiler which ordinarily is difficult to operate with fuel oil, owing to limited furnace conditions.

We think, however, that the caption given to Fig. 4, "Type of Oil Burner Used," is somewhat misleading, as this illustration is merely a diagram serving to show the method by which the wide range in capacity is obtained without loss in atomizing effect, and to indicate further the manner in which the burner may be controlled through this wide range, merely by the operation of one valve. If, however, the caption had read "Diagram Illustrating Method of Control of the Mechanical Atomizer," it would have been correct.

The illustration, Fig. 5, shows the general plan of the burner clearly, and it will be evident on inspection of this figure that the burner is readily attached through the air register in an accessible position for the firemen, and that both connections—to the oil delivery and to the oil-return conduits—was made in a single operation by the use of a quick-detachable yoke coupling.

The accompanying illustration shows the atomizer with the "burner end" of the coupling assembled, and also the various parts of the burner disassembled.

The oil passes through a port in the bronze coupling casting *A*, passes into the burner *B*, which consists of heavy hydraulic steel tubing, and flows along the annular space formed between the inner wall of this tubing and the inner pipe *F*, which, when assembled, is concentric with the barrel, to the ports in the plug *E*. From there it flows through suitable channels in the tip *D* to a central chamber, where it receives a whirling motion and issues through the orifice in the tip in the form of spray.



PARTS AND ASSEMBLY OF OIL BURNER

The bypassed or returned oil goes back through the center of the plug, through the inner tube to the outlet conduit in the coupling casting, which registers with a

similar port in the yoke end of the coupling, which, in turn, is attached to the front plate of the air register.

This latter casting is not shown in the illustration, but, as stated, the connection is made by tightening a setscrew in a movable yoke; thus the operation of connecting up the burner to the oil-delivery and return lines is a simple one. The cap *C* serves to hold the tip and plug firmly in position on the end of the burner barrel.

It will be noted, therefore, that the design of the burner is simple, compact, accessible for cleaning, and, while performing the important office of producing the spray and providing for the return of the bypassed oil, is, at the same time, such as to permit the spray to be delivered through the opening in the inner wall of the furnace.

Guarantee tests have recently been conducted on this type of burner with oil of 10.6 Baumé specific gravity, and from results obtained these burners are to be used in the S.S. "Leviathan," now being reconditioned at Newport News, Virginia. E. H. PEABODY,

Peabody Engineering Corporation.

New York, N. Y.

Steam Traps—Their Selection, Installation and Upkeep

As constructive criticism of Mr. Smiley's article in the July 11, issue the writer wishes to differ from him in regard to a few points. Both factors that he mentions as the ones to consider when selecting a trap are, in reality, one. They are, taken together, capacity. Of equal importance, and, in the minds of many engineers, of greater importance, is reliability.

Capacity is a function of both area of opening and available pressure to force water through the opening. Reliability takes in many things, and means the ability to handle, up to its capacity, all the water that may be delivered to it, promptly and under any and all conditions, clean or dirty, hot or cold, and to perform consistently. Traps that will do this, week after week, month after month, are on the market. They are built in capacities of from 2,400 to 21,000 gal. per hour with 100 lb. pressure. They work equally well over a wide range of pressure, from 350 pounds down to 2 pounds, with no change in the trap itself. For pressures above 175 pounds, the body of the trap should be a steel casting. The writer knows of installations where not one cent has been expended for repairs over periods of five, eight, and in one case twelve years, and the traps are yet in perfect order and "drop tight."

Consider the probabilities for error in the test given for determining the leakage through a trap. Skilled testing engineers, with the most accurate instruments available, place in their reports the item "unaccounted for," which shows wide variations when several tests are made. The set of data given in the article shows a temperature range of 40 deg. F. One-half degree error in each reading is probable, making the possible total error in this one item of at least one degree, or two and one-half per cent. Add to this the probable error of not less than one per cent in weighing, and you get a value in the results that is far from satisfactory. But why make such a test, which at best lasts for a short time, when there is a better method of showing whether the trap is tight or not? Some ten years ago the superintendent of steam at one of the steel mills in Pennsylvania, to get a check on the action of a trap, placed a recording thermometer on the discharge. He had the charts brought to him for eighteen months. For all that time he had a record of every time the trap discharged, and whether it leaked steam. These records showed the trap discharging about every ten minutes, with no sign of blowing through. One recording thermometer, and a well on the discharge of every trap, give the engineer opportunity to check up all traps; also, he can make a fair estimate of the total amount of water discharged over a given period.

It is also stated that care must be taken that the steam is not superheated when it reaches the trap. With nearly all traps that is true. There are, however, installations of traps fitted with steel bodies and monel valves operating on superheated lines. These traps have been in service a long time, and there are long periods when there is no water in them. They remain tight, and when water does come, they operate properly.

Chicago, Ill. O. R. MCBRIDE.

Should Boiler Code Bar Emergency-Fleet Boilers from Land Installation?

I observe in the July 11 issue that the Commissioner in Pennsylvania having charge of boilers has decided that those built for the United States Shipping Board are not eligible for installation in that State. The reason for this is that the boilers do not in all respects comply with the rules of the Code of the American Society of Mechanical Engineers.

It seems to be overlooked by many persons that the object of the Code and other rules is to promote safety, and that most of the rules now in operation have nothing whatever to do with safety. The requirements of rules, outside of those for safety, are merely those which from various points of view are advisable. Even about these there are differences of opinion.

The only thing that the Code requires that really promotes safety is the use of butt longitudinal joints in boiler and drum shells. It has not gone as far as it should, for it still allows dished drum heads, which frequently blow out, and also one-sided longitudinal joints and weak manhole construction in shells.

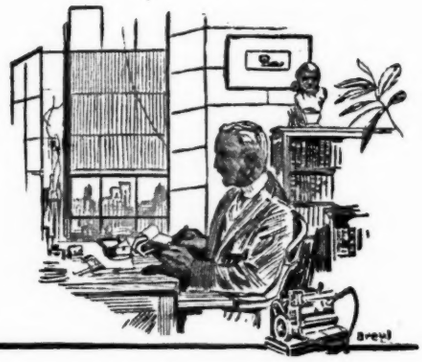
Now, the boilers built for the Shipping Board are designed and constructed as well as any other boilers. The material was all carefully inspected at the mills and the construction was constantly inspected by an Emergency Fleet Inspector, by inspectors from the American Bureau of Shipping, from the United States Steamboat Inspection Service and sometimes from Lloyds. It is regrettable that these excellent boilers should be wasted, merely because they do not conform in some trivial and unimportant respects to the requirements of the various land rules. As long, however, as the laws establishing the adoption of rules does not make any exception to their application, this state of affairs must exist.

In my opinion, what should be done is to have permission granted by the law to have the boilers examined by properly authorized inspectors for the purpose of ascertaining whether they are safe; and if they are safe, they should be permitted to be used. The purpose of the rules is not and should not be to prevent safe boilers from being used, but to make certain that newly constructed boilers shall be safe. F. W. DEAN.

Wheelock, Dean & Bogue, Inc., Engineers,

Boston, Mass.

QUESTIONS AND ANSWERS



Oil-Throwing by Flywheel

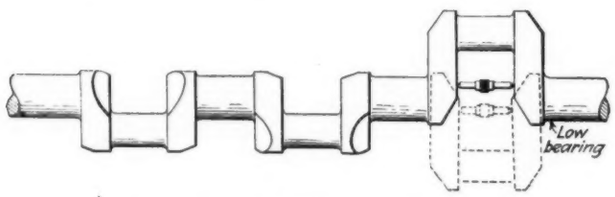
We are troubled by oil from our engine-shaft bearings being carried along the shaft and thrown out by the flywheel. How can this be prevented? N. J.

The simplest method is to place on the shaft a light but close-fitting collar with one side formed to larger diameter with a thin edge so the oil may be thrown off by centrifugal force. The oil then may be gathered in a stationary pot or pan with a splash cover, to surround the collar clear of the shaft.

Checking Crankshaft Alignment

Is there any way to find if the main bearing of a three-cylinder oil engine is in alignment without removing the shaft and running a center line? L. G. R.

If the bearings are not in line, that is, if one or more bearings are worn low, the crankshaft will have a slight bow between these bearings. If the crank is up,



CHECKING ALIGNMENT OF CRANKSHAFT

as shown in the sketch, the distance between the throws will be greater than when the crank is at its lowest position, as shown by the dotted lines.

If an inside micrometer is placed between the throws when the crank is at the top, then if the bearings are level the distance will be the same when the crank is placed at the bottom, and greater if one or both of the bearings are low. This method is outlined in the illustration, showing in exaggerated form the result of a low bearing.

Extermination of Algæ in Cooling Pond

We are having considerable trouble in keeping our cooling pond free from growths of water weeds. What remedy can be applied? W. A.

Most vegetable growths, particularly accumulations of the long-fibered variety of algæ, can be exterminated by one part of copper sulphate to about one million parts of water. The commercial salt has the chemical formula $CuSO_4$, and is known as "blue vitriol." In barrel lots the material costs 6 to 10 cents a pound. For treatment of the water, place the blue vitriol in coarse sacks, each containing about one-half peck of the blue vitriol suspended below the surface of the pond. To kill growths of water weeds along the sides of the pond, slowly drag one of the sacks containing the blue vitriol through the water along the margins of the pond.

Equality of Diagrams Lost with Variation of Load

After re-erecting a Corliss engine, the valve gear was adjusted to obtain equal friction diagrams, but when the engine carries its load there is considerable inequality of cut-off in opposite ends of the cylinder. Should not valve-setting with a friction load be sufficient? W. L. S.

On account of the variation in angularity of the connections for different points of cut-off, few types of valve gears give the same relative size of diagrams from opposite ends for different loads. The discrepancy is widest between the friction load and full load. It is desirable to obtain the best distribution of steam when the average power is developed, and adjustments should be made to that end, regardless of inequality that may result to the friction diagrams.

False Indications of Glass Gage

What causes water to rise and fall in a glass gage of a boiler? E. E. R.

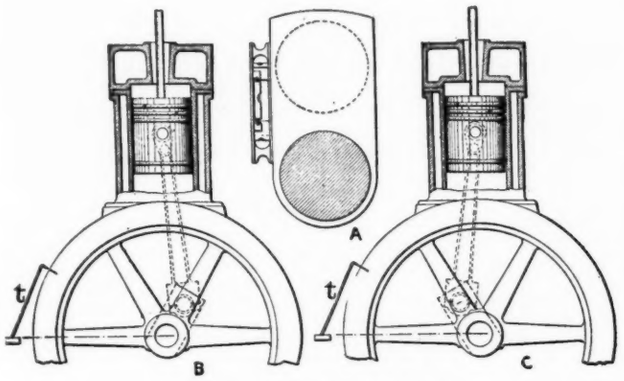
The water rises and falls because there is an actual wave of water within the boiler, or surging due to the circulation. When there is generation of steam, the circulation of the water has a tendency to drive it higher at one end than the other end of the boiler, which results in a glass gage indication of higher or lower water than the actual average water level. Activity of boiling has a tendency to increase the steam pressure and lower the water level in its vicinity, and near points where the steam pressure is reduced by discharge of steam from the boiler, there is a tendency of higher water level. When a boiler is in operation, these disturbances always are present to greater or less extent, causing the glass gage to indicate higher or lower water than the true or average level.

Locating Dead Center on Trunk-Piston Engine

I am familiar with the method of locating dead centers on a steam engine when the crosshead may be scribed and would like to know how it is done on a trunk-piston vertical gas engine? W. L. R.

First get a steel rod, pointed at each end as shown at *t* in the illustration *A*, *B* and *C*. Remove one of the valve cages and turn the engine until the piston is a short distance from its top center. Insert a steel

rule through the opening and make a mark on it level with the cylinder top. Now with one end of the rod or trammel supported on a stationary point, make a mark on the flywheel as shown in sketch *B*. Next turn the engine beyond dead center until the piston is again at the same distance from the head with the connecting rod on the other side of the center as in illustration *C*.



LOCATING DEAD CENTER

Again mark the flywheel and find the midposition of the two trammel marks. Turn the engine back until the trammel cuts this midpoint. The piston is then on dead center.

If the engine has planed crank arms or throws, it is possible to find the dead center by placing a plumb-level as shown at *A*. This, however, is not very accurate.

Horsepower of Pump

How can I find the horsepower of a pump? S.B.

The horsepower of a pump may apply to either the input or output. Whichever is referred to should be distinctly designated or understood. With a direct steam-driven pump, the power output is the indicated power developed in the steam end, obtained by applying a steam engine indicator to the steam cylinder, or cylinders, in the same manner as in obtaining the indicated power of a reciprocating engine for the purpose of obtaining the mean effective pressure for computing the indicated power by the formula,

$$i.hp. = \frac{P \times L \times A \times N}{33{,}000}, \text{ where}$$

P = mean effective pressure, lb. per sq.in.,
L = actual length of stroke in feet,
A = area of piston in sq.in.,
N = number of single strokes per min.

Thus, for a single double-acting pump—if the average m.e.p. in the steam cylinder is 82 pounds per sq.in.; actual length of stroke 10 in., or 0.833 ft.; dia. of steam cylinder 8 in., giving a head-end piston area of $8 \times 8 \times 0.7854 = 50.265$ sq.in.; dia. of piston rod, $1\frac{1}{4}$ in., or $1\frac{1}{4} \times 1\frac{1}{4} \times 0.7854 = 1.227$ sq.in., giving a net area of piston on the rod side $= 50.265 - 1.227 = 49.038$ sq.in., making the average net piston area $(50.265 + 49.038) \div 2 = 49.651$ sq.in.; and there are 90 single strokes per minute—then the power input or i. hp. of the steam end would be,

$$\frac{82 \times 0.833 \times 49.651 \times 90}{33{,}000} = 9.2 \; i.hp.$$

The power output is the "water horsepower," or theoretical horsepower that could be developed by the water that is actually discharged, if raised to the height or head corresponding to the pressure at which the water is discharged from the pump, plus the suction lift in feet. Thus, if the quantity actually delivered is 115 gal. per min., the suction lift to the point of discharge is 5 ft., and the water is discharged from the pump against a pressure of 95 lb. gage or $95 \times 2.309 = 219.355$ ft. head, then the power output would be

$$\frac{(219.355 + 5) \times (115 \text{ gal.} \times 8.33)}{33{,}000} = 6.5 \; \textit{water hp.}$$

Submerged-Tube Vertical Boiler

What is the difference in arrangement and relative advantages of the ordinary vertical fire-tube boiler and the submerged-tube vertical boiler? C. R. F.

In the ordinary vertical fire-tube boiler the tubes extend from the firebox tube-sheet through the water space and steam space of the boiler to the tube-sheet head in the upper end of the shell, as shown in Fig. 1. The upper ends of the tubes are thus above the water level and are exposed to the high temperature of the heated gases on one side and to steam in the steam space *S* on the other side. The tubes are likely to become overheated and leak from unequal expansion of the tubes and head or the shell to which the tube sheet is attached.

In the submerged-tube type, the upper tube sheet, as shown in Fig. 2, is below the water line and the shell is extended higher, with a steam space *A* and part of

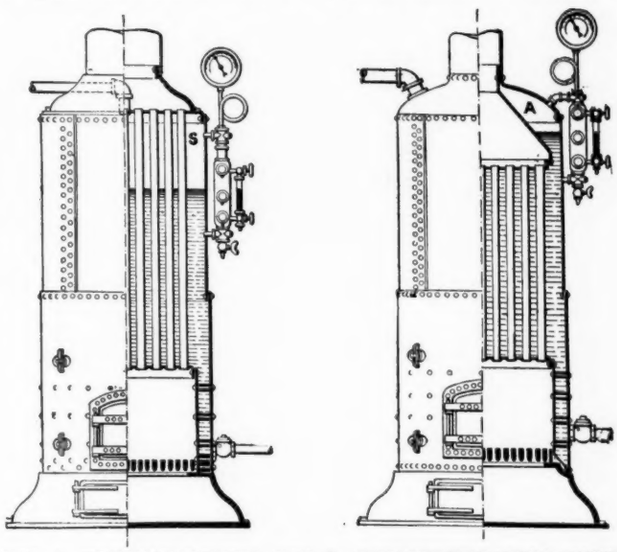


FIG. 1. ORDINARY TYPE. FIG. 2. SUBMERGED-TUBE TYPE VERTICAL FIRE-TUBE BOILERS

the water space surrounding the smoke uptake. The submerged type has the disadvantage, however, of having a small steam disengagement surface, and steam is likely to collect under the upper tube sheet and force water into the steam connection. The submerged-tube design has the further disadvantages of smaller steam space, less accessibility for re-expanding the upper ends of the tubes and greater cost of construction.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Wisconsin State N.A.S.E. Meets at Madison

From July 26 to 28 inclusive, in the magnificent Capitol Building at Madison, the Wisconsin State Association of the National Association of Stationary Engineers held its annual convention jointly with the seventh annual school for state power-plant engineers. The business sessions of the convention were held in the Senate Chamber and the exhibits, to the number of seventy-eight, circled around the rotunda on the first floor. A number of lantern-slide lectures on topics of general public interest rounded out the program and helped make the convention one of the best on record. Although the attendance was scarcely up to expectations, registration showed that a total of 335 visiting engineers was extended by Governor Blaine, through his chief executive clerk, F. W. Ruehl, and in behalf of the city by Mayor Kittleson. Suitable responses were made by National Secretary Raven, John W. Lane and L. H. Stark. The usual committees were appointed and the convention was ready to function. The Milwaukee visiting club was commended for its inspiring work, and reference was made to the passage of engineers' license laws by a few more cities of the state.

The report of the License Committee brought out considerable discussion. It was their recommendation that active work on a state license law be postponed for at least a year owing to lack of funds and to the fact that all their energy might be required in combating or at least modifying the work of the electricians and steamfitters who were trying to force through state license laws of their own. A standing license committee appointed by the presi-

DELEGATES AND GUESTS, WISCONSIN STATE CONVENTION N.A.S.E. ON STEPS ON CAPITOL BUILDING

were present, 60 of the number being ladies, who took part in the meetings of the Ladies Auxiliary and contributed to the entertainment, consisting of music and dancing, a most enjoyable picnic supper, a boat trip on Lake Mendota and a banquet on Friday evening. The hospitality shown throughout the convention was characteristic and of the high degree of excellence generally attained in the Badger State.

On Wednesday morning the school completed the work outlined in a single session, with J. C. White, state chief engineer of power plants, presiding. For a number of years the engineers of the state institutions have been linked together in one big organization, with headquarters at the Capitol power plant. The annual meetings give them an opportunity to exchange experiences, become more familiar with the methods adopted by the management and to maintain the morale of the organization. The general result has been a great improvement in the methods of operation and in the results obtained in the various plants. In a brief address at the meeting John W. Lane highly recommended this co-operative effort, following with an appeal to the individual to improve his opportunities and to let his work be known principally through the technical press in order that he might be among those selected to fill the larger jobs of the country.

At the opening session of the state association Wednesday afternoon, J. J. Novotny presided. President Fenn referred to the part the stationary engineer had assumed in the conservation of national resources. Welcome to the dent might carry on the fight and at the same time help various cities in passing license laws. Then, when the public had been educated to the benefits of the movement, the passage of a state law would be facilitated. The convention body did not concur. It was pointed out that the delay would be over two years, as after next fall the legislature would not meet within that time, and that the passage of city laws had always hindered instead of advanced a state law. The decision was to proceed with the work for a state law.

Recognizing the fact that engineers as a body lack legal standing owing to the fact that they have no direct training to meet certain ends, a resolution was proposed that the association use its influence to introduce indentured apprentices. The indenture sets up certain standards toward which all engineers should work, thus insuring a definite legal standing. It would give the right to take apprentices into the plant and give them the training called for. The resolution was passed, although some doubt was expressed as to the feasibility of the plan because of the diversity of the work of the engineer and the wide variation in power plants and in the type of equipment installed.

Another resolution called for the passage of national legislation to enforce the placing of the proximate analyses and the B.t.u. value on the bill of lading accompanying every car of coal. Owing to the uncertain quality of coal furnished, particularly in some localities, such a movement seemed justified and quite as feasible as the pure-drug act and other measures to enforce quality. The resolution was

passed with the suggestion that it be forwarded to the state representatives and senators in the National Capitol.

Following business sessions, and in the evening, a number of lectures somewhat away from the beaten path were given for the entertainment and the instruction of the engineers. The Sanford Riley reels showing the operation and construction of the underfeed stoker were highly appreciated. Prof. A. P. Haake, of the University of Wisconsin, spoke on the "The Economic Situation and a Remedy." Frank A. Cannon, secretary of the Wisconsin Good Roads Association, presented an illustrated lecture on "Scenic Wisconsin." Prof. C. M. Jansky explained the operation of the wireless telephone. Harry Santhoff, attorney at law, discussed the St. Lawrence Waterway Project, bringing home to the audience the great advantages that this proposed ocean route would offer to the states of the Middle West.

In a welfare talk John Lane emphasized the need of broadening the work of the state conventions. There should be more welfare discussions so that more of the engineers attending would take part. This constituted the success of any convention. Topics should be sent in early, published before the convention and all should come prepared to discuss them.

At the final session the following officers were elected: President, L. H. Stark, of Milwaukee; vice-president, C. Z. Wise, of Madison; secretary, J. P. Murphy, of Milwaukee; treasurer, Henry Ziebell, of Oshkosh; conductor, George Stien, of Stevens Point; doorkeeper, C. W. Reed, of La Crosse. Robert Fenn, retiring president, was recommended as state deputy. Stevens Point was the unanimous choice for the next convention city.

Burning Coal Dust on Coxe Stoker*

In this report are given the results of the preliminary investigation of the performance of a Coxe stoker installation at the plant of the Illinois Maintenance Company, Edison Building, Chicago. As the installation had been making smoke and giving high flue gas temperatures, the investigation was undertaken to find the cause and a remedy.

The installation consists of a three-pass cross-flow water-tube boiler having 6,280 sq. ft. of heating surface and fired

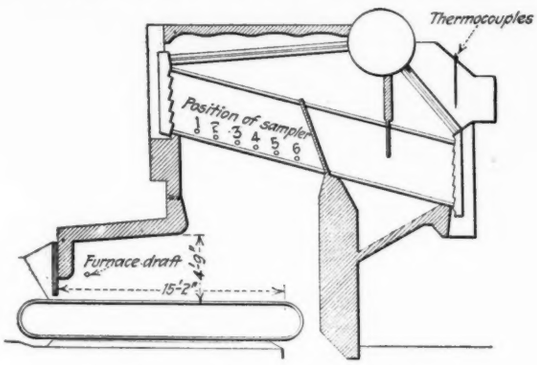


FIG. 1. TYPE OF BOILER SETTING

with a stoker 10 ft. 4 in. wide and 15 ft. 2 in. long, the type of setting being shown in Fig. 1.

The fuel burned consisted of about equal parts of anthracite coal dust waste from local yards and fine bituminous coal screenings, so that it contained a large percentage of fine dust and was of poor quality. The fine dust was blown out of the fuel bed and a large part of it carried by the gases into the boiler. Small particles of molten ash were blown on to the side walls, where they accumulated and flowed down the wall. When this flowing molten ash reached the grate, it was cooled by the air coming into the furnace between the side walls and the stoker, and solidified, gradually building ledges of clinkers on the side walls, which extended 1 ft. into the furnace, as shown in Fig. 2. These clinker formations acted like plows, pushing the fuel away from the side walls, and heaping it in ridges. It was difficult, if not impossible, to break the clinker formation with a slice bar, and it presented the worst trouble encountered in the operation of the furnaces. Some of the molten ash particles were carried into the boiler, where they stuck to the tubes and formed clinker

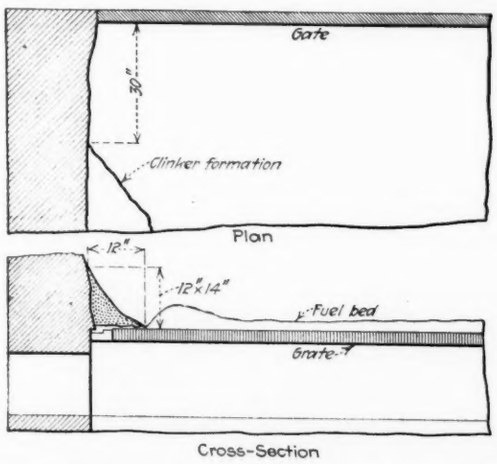


FIG. 2. FORMATION OF CLINKER ON THE SIDE WALLS

crustations, which reduced the gas passages and were difficult to remove.

It was thought that possibly there was an insufficient supply of air over the fuel bed on the front half of the grate, and that smoke might be produced by the incomplete combustion of the gases rising from the fuel bed. It was also thought possible that the combustible gases from the front part of the stoker did not mix well with the air coming into the furnace through the rear part of the stoker until they passed through part of the boiler, and that secondary combustion caused high flue gas temperature.

Samples of gases were therefore collected at several points at the bottom of the first pass, to determine whether any unburned gas entered the boiler. The points at which these samples were collected are indicated in Fig. 1. All samples were taken about 4 ft. from the side wall. Six sets were collected and analyzed, and the results showed that there was practically no combustible gas entering the boiler, so that there could be no secondary combustion. Temperatures of flue gases measured at about the same time indicated the absence of secondary combustion. The highest flue gas temperature obtained was 632 deg. F., when the boiler was operating at 200 per cent of rating. This temperature was considered high, but it appeared to be uniform, without any abnormal fluctuations such as are usually found when secondary combustion takes place. Afterwards the boiler was taken off the line and examined internally. It was found dirty. The lowest row of tubes was almost completely filled with mud and scale, and the tubes at the top contained scale about ⅛-in. thick. This dirty condition of the boiler accounted in part for the high flue gas temperature obtained. Close observation through a smoke periscope indicated that no smoke was made with this fuel.

Owing to the large percentage of fines in the fuel, there were numerous thin spots and holes formed by the blast in the front part of the fuel bed, and sufficient air flowed over the fuel bed through these holes and thin spots to nearly complete the combustion in the furnace. The fuel bed was anything but of uniform thickness, and presented the appearance of many irregularly deposited small heaps of fuel, with many bare spots among them through which air was blown into the furnace.

*Contribution by F. B. Orr, to report of Station Operating Committee, National District Heating Association, Cedar Point, Ohio, June 20-23, 1922.

The worst trouble encountered in the operation of this installation, when burning the present fuel mixture, was the formation of clinkers on the side walls. The best remedy for this trouble would be to equip the furnace side walls with water boxes which could be made by placing two 4-in. tubes in each side wall immediately over the grate, and connected to the circulation of the boiler.

A simpler remedy, although perhaps not as effective against the clinker formation, would be ventilated side walls with the air openings placed above the top of the fuel bed, so as not to blow the fuel away from the side walls.

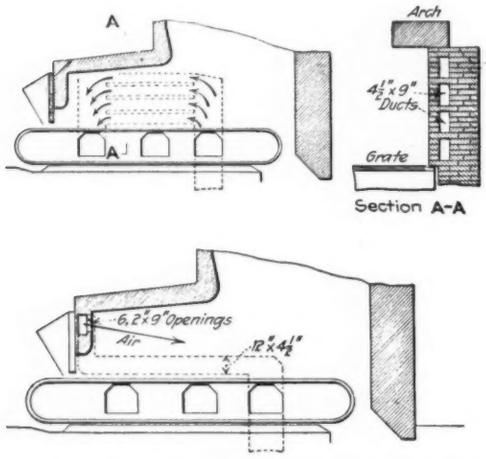


FIG. 3. (ABOVE) PASSING AIR THROUGH SIDE WALLS INTO FRONT TUYERE BOX; (BELOW) AIR PREHEATED IN SIDE WALLS DISCHARGED

There is also a possibility that too much air would be introduced into the furnace through such ventilated side walls.

The side walls could also be ventilated by making them hollow and passing all the air needed in the front tuyere box through them. This scheme is shown in Fig. 3. It has the advantage that the air used in cooling the wall is not blown directly into the furnace, so that the excess air is not increased.

If the ordinary bituminous stoker fuel were used, air would have to be supplied over the fuel bed to obtain complete combustion in the furnace. This air could be supplied under pressure through the side walls and injected into the furnace through inlets in the front wall, as shown in Fig. 3. This air would probably cool the side walls sufficiently to prevent the formation of objectionable clinkers.

Federal Power Commission Works Against Odds

The Federal Power Commission, in its work of executing the provisions of the Federal Water Power Act, is greatly handicapped by an entirely insufficient personnel. Such is the plain statement contained in a report issued by the Commission's executive secretary, O. C. Merrill.

During the first two years in the life of the Commission, 321 applications for water power construction, involving more than 20,000,000 hp., have been received. This is more than twice the amount of existing water power installations in the United States. It is more than six times the aggregate of all applications for power sites during the preceding twenty years.

In connection with these applications, the Commission is required to investigate the proposed plans and sites from the standpoints of safety, sound design, full utilization of the power resources of the stream, and effects upon interstate commerce when the navigability of the stream is in doubt. It must make valuations of all properties licensed under the Act and constructed prior to the issuance of license; it must investigate and pass upon applications for restoration to entry of lands within power-site reserves; it must establish a system of accounting to determine the net investment made; it must see that licensed projects are properly maintained and that depreciation reserves are provided for.

These are the principal duties of the Commission under the terms of the Water Power Act. And for the fulfillment of these duties, "the greatest task with respect to water powers that the government has ever had," Congress created a commission composed of only two men, an executive secretary and an engineer-officer. Additional personnel has been "borrowed" from other departments from time to time, until the commission now consists of eight engineers, two attorneys, two accountants, and eighteen clerks, but even this force has been found entirely inadequate, according to the secretary's report.

For two years the Commission has been working under these unsatisfactory conditions. It has been found impossible to comply with certain provisions in the Water Power Act, notably that relating to valuations. Cases involving over $100,000,000 are awaiting action, because the Commission has been unable to obtain men with the necessary experience in this work. In certain cases, in order that much-needed power developments might not be delayed, provision for valuation in the future has been made. This, however, is almost certain to lead to prolonged and costly litigation, which would have been unnecessary had the Commission been given at the start the means of carrying out this part of the law.

The executive secretary, Mr. Merrill, reports a "reasonable amount of progress," in spite of the obstacles against which the Commission has labored, but he nevertheless makes an emphatic plea that the means for complete fulfillment of the water-power law be at once provided. His report closes with these words:

There is more water-power development under way at the present time than at any previous period in our history. The greater part of it is being developed under the provisions of the Federal Water Power Act. There is much more waiting to be used. If we are to preserve our diminishing fuel supply, are to reduce the burden of coal transportation, are to increase the supply of electric energy and reduce its cost, we must utilize our water power to the fullest practicable extent. We have a law which, though by no means perfect, does provide reasonably satisfactory conditions, and under which large-scale development is proceeding. Instead of being obliged to drift along with an administration of the law which, under existing circumstances, is necessarily insufficiently coördinated and only partially effective, the obstacles should be cleared away, whatever their nature, and there should be substituted a positive attitude both of encouragement and of assistance in the development of our water powers.

The American Engineering Standards Committee, by letter ballot, has approved the National Electrical Safety Code of the Bureau of Standards, which covers the generation, distribution and utilization of electricity for power, light and communication. In making public this decision, the Standards Committee announces that there is now in process of formation a thoroughly representative sectional committee to consider any revision of part 2 of this code, entitled "Rules for the Installation and Maintenance of Overhead and Underground Electrical Supply and Signal Lines," which may be deemed necessary by any of the interested parties. There are also being organized three subcommittees to take up the unification of traffic specifications under the three following heads: signal lines crossing railways, power lines crossing railways and power lines crossing signal lines.—*Electrical World.*

After the coal operators had obtained an injunction in a District of Columbia court restraining the Federal Trade Commission from carrying on an investigation into the basic facts of coal production, neither President Harding nor Congress showed the faintest sign of interest in the significance of this legal maneuver. Had the Federal Trade Commission been strongly supported by the White House and the Capitol, there would be an informed public opinion that could be mobilized to settle the coal strike.—*N. Y. World.*

News in the Field of Power

Three-Shift Versus Two-Shift Working Day

The results of an investigation of working conditions in the continuous industries (those operating twenty-four hours a day) will be placed before the Executive Board of the American Engineering Council of the Federated American Engineering Societies, at board meetings to be held in Boston on Sept. 8 and 9.

A report on the feasibility of changing from the two-shift day of twelve hours per shift to the three-shift day of eight hours per shift will be presented by Horace B. Drury, formerly of the faculty of Ohio State University. Mr. Drury will base his conclusions upon thorough investigation of a large number of continuous industries. A single industry, that of steel manufacture, will be considered in a more specialized report made by Bradley Stoughton, former secretary of the A.I.M.M.E.

The number of shift workers in the United States is estimated to be between 500,000 and 1,000,000. This includes industries in the South and Far West, as well as in the East and Middle West. According to the investigators, the committee in charge of this work is endeavoring "to chart what has hitherto been a practically unexplored field."

Chile Plans Hydro Developments

Hydro-electric developments in central Chile amounting to more than 100,000 hp. are outlined in a report recently submitted by two British engineers, F. S. Badger and Norman Rowe, according to the trade supplement of the London *Times*. The Colorado and Maipo Rivers in central Chile were explored by these engineers and recommended as being ideal for hydro-electric power development. The first plant to be erected will consist of three generating units of 10,000 hp. each, with an ultimate capacity of 40,000 hp. Santiago, Limache and Valparaiso are among the cities to be served by the new project.

New Water Power Regulation Called For

Although it was decided at the last meeting of the Federal Power Commission that the provision of the Water Power Act covering depreciation could not be materially altered without amending the Act itself, no action was taken on an equally troublesome regulation, that which deals with accounts and reports. This regulation fails to meet the requirements of the Act, according to the chief counsel of the Commission.

The work of the Commission is being hampered, and it is hoped that at the next meeting provision will be made for drawing up an accounting system which, while it conforms with the specific requirements of the Act and with sound accounting practice, can yet be adapted to meet the needs of licensees and others who have objected to the existing regulation.

Recommend $2,000,000 for Penn State College

Recognizing the need of Pennsylvania State College for new buildings, new equipment and salary increases, the Industrial Conference Committee, a body of engineers, has recommended that the state legislature appropriate funds amounting to $2,000,000 for the purpose. A main engineering building to replace that destroyed by fire in 1918, a building for the electrical engineering department and a foundry and transportation building are among those recommended by the committee.

The members of the committee expressed themselves as being "shocked at the meager appropriations and low salaries paid in one of the largest and most important schools of engineering in the United States."

Transportation Chief Problem in Coal Situation

The Federal Government is now faced with a problem very different from that with which the Fuel Administration had to deal during the war. The situation now is a traffic problem, somewhat similar to the one very successfully handled by the Central Coal Committee in 1919 and 1920. As a result of the work done by that committee, it is probable that the new coal commission will be formed along similar lines. However, it is not likely that methods used by the Central Coal Committee in regard to paying for coal will be followed. Since the situation is being controlled through the powers vested in the Interstate Commerce Commission, the execution of any plan must be carried out by the railroads. For that reason Henry B. Spencer, a former member of the Central Coal Committee, has been named as the fifth member of the President's proposed coal commission of five men.

That control of coal distribution must continue for the remainder of the calendar year, and possibly for the remainder of the coal year, is becoming more and more apparent. A large corps of workers will be required. It is probable that an appropriation of $200,000 will be requested for the purpose. In addition to the need for an appropriation it is very apparent that the administration soon will request legislation giving out-and-out power to fix prices and to seize coal. It is possible that a revolving fund will be asked for, so that the administrative committee can buy and sell coal when the occasion demands.

Senator Borah Introduces U. S. Coal Commission Bill

Action on President Harding's proposal to establish a commission for investigation of the coal industry was taken on July 26, when Senator Borah of Idaho introduced in the Senate a bill to establish a commission to be known as the United States Coal Commission. Briefly summarized, the provisions of the bill are as follows:

The proposed commission will be composed of three members appointed by the President, with the advice and consent of the Senate. Members of the House of Representatives and United States Senate are ineligible. Of the three members, one will be appointed from a list of three nominees presented to the President by the National Coal Association, one will be appointed from a similar list submitted by the president of the United Mine Workers Association, and the third will be a representative of the public, having no connection in a business way with the coal industry.

The life of the commission is limited to one year from the date of the passage of the act, unless otherwise provided by Congress. The salary of the members of the commission is set at $8,000 a year.

The principal duty of the commission is to make such a study of the coal industry as will enable it to assist Congress in the passage of legislation relative to regulation and control of the coal industry by the Government.

Specifically, the commission is to report on: First, ownership and title of the mines; second, cost of production; third, profits realized by the operators or owners of the mines during the last ten years. The commission must also report on the subject of irregular production and suggest possible remedies for this condition, such as would aid in the establishment of a wise Governmental policy for the coal industry.

The commission is also required to submit recommendations relative to (1) standardization of mines upon the basis of productive capacity (and regarding the closing down of mines that fall below the standard), and (2) standardization of the cost of living for mine workers, and of reasonable living conditions which must be supplied them. It is also desired that there be established a basis of arriving at the overhead cost of producing coal and delivering it at the door of the consumer.

Under the terms of the bill the commission shall render its first report and recommendations as soon as practicable, and not later than nine months from the passage of the act to Congress and to the President.

Other minor provisions of the bill relate to the sources of information open to members of the commission, and to

the salaries of such employees as the commission may find necessary for the efficient discharge of its functions.

Senator Borah's bill has been referred to the Committee on Education and Labor. So far no further action on it has been taken.

Wages Still 80 Per Cent Higher Than Before the War

Contrary to popular belief, the average actual weekly earnings of workers in the principal American industries were, during the first few months of 1922, 80 per cent above the average of July, 1914, according to a comprehensive analysis of industrial conditions just made public by the National Industrial Conference Board. Since the peak in 1920, weekly earnings have fallen 25 per cent and total employment 35.8 per cent, up to January, 1922. Real weekly wages, taking into account the purchasing power of the money received, were 11 per cent higher at the close of 1921 than before the war, in spite of extensive wage reductions and curtailment of plant operation due to industrial depression.

The Bureau of Mines, in its operation of the Government fuel yards, has been able to meet all fuel demands of the Government departments in Washington during the strike without experiencing a coal shortage. This has been accomplished by always maintaining certain supplies of coal in bins of Government departments and also by arranging with several of the former contractors to continue coal shipments during the strike without binding contracts. This arrangement has enabled the yards to secure a regular supply of fuel from non-union mines in the New River district. During the first two weeks of the strike some coal was also received from Pennsylvania mines, but this was cut off when the mines were unionized and ceased production. Officials of the fuel yards are gratified at being able to continue operation during this, the third period of acute coal shortage since the yards were established.

New Publications

A.S.H.V.E. Guide, 1922: First annual edition. Published by American Society of Heating and Ventilating Engineers, 29 W. 39th St., New York City. Cloth; 6 x 9 in.; 210 pages text, 140-page catalog data section. Price, $3.

This volume, the first of a series to be issued annually, is a very complete collection of practical information and data pertaining to heating and ventilation. The book consists of a section devoted to society standards and codes, committee reports and technical papers; a general data section, containing many useful tables; and a directory of consulting heating and ventilation engineers. In addition, the products of the principal manufacturers of heating and ventilation equipment are alphabetically listed and described in a special "catalog data section" in the back of the book.

Power House Design. By John F. C. Snell. Published by Longmans Green and Co., New York and London. Cloth, 6 x 9 in.; 516 pages; 201 illustrations. Price, $15.

This second edition of Snell's "Power House Design" covers much that was omitted in the first edition. The author has successfully attempted to take up the phases of engineering entering into the choice of equipment and station design. While the machinery discussed represents English and not American practice, the American engineer will find much information, particularly as to machine efficiency. Especially interesting are the inserts showing large British central stations. The consulting and designing engineer will class this volume as a valued addition to the present fund of information on present day power-plant tendencies.

World Metric Standardization: An Urgent Issue. Compiled by Aubrey Drury, in collaboration with other members of the World Metric Standardization Council, 681 Market St., San Francisco, Cal. Published by the same organization. Cloth; 6 x 9 in.; 524 pages. Price, $5.

A vast compilation of opinions, data and arguments supporting the introduction of the metric system of weights and measures as the legal standard in the United States and Great Britain, which two countries are, according to the editors, the only ones still persisting in the use of the "antiquated jumble" of weights and measures known as the "English system."

Coming Conventions

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Des Moines, Ia., Sept. 11-16. Annual conventions and exhibitions of the State Associations scheduled as follows:
Minnesota, at Minneapolis, Aug. 9-11; C. A. Nelsen, 800 22nd Ave., N. E., Minneapolis.
Iowa, at Des Moines, Sept. 10-11; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.

Universal Craftsmen Council of Engineers; Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Annual convention and exhibition at Cleveland, Aug. 7-11.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Pacific Coast Convention at Vancouver, B. C., Aug. 8-11.

National Safety Council, 168 N. Michigan Ave., Chicago, Ill. Eleventh Annual Safety Congress, Detroit, Aug. 28-Sept. 1.

International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention and exhibition at Minneapolis, Minn., Sept. 11.

Association of Iron and Steel Electrical Engineers, 1007 Empire Bldg., Pittsburgh, Pa. Annual convention and exhibition at Cleveland, Ohio, Sept. 11-16.

Personals

Fred F. Sherwood, formerly chief engineer of the Consumers Ice Co., is now superintendent of power with the Chicago Cold Storage Warehouse Co.

Lieut.-Com. L. N. Linsley, U. S. N., was the recipient of the first Doctor of Engineering degree bestowed by Johns Hopkins University.

Business Items

The Elliott Co., of Jeannette, Pa., manufacturer of power accessories, has appointed S. D. Green, formerly with the Worthington Pump and Machinery Corp., as sales engineer in the company's Boston office, 830 Massachusetts Trust Building.

The Marvellum Co., of Holyoke, Mass., has elected A. W. de Revere to the position of vice-president in charge of sales. Mr. de Revere was formerly general sales manager of the Green Fuel Economizer Co., of Beacon, N. Y. The Marvellum Co. manufactures specialty papers for use as catalog, magazine and box covers.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	July 24, 1922	July 31, 1922
Pool 1,	New York	.....	.....
Smokeless,	Columbus	$5.50–6.50	$7.50–8.75
Clearfield,	Boston	3.50–3.75	5.50–6.50
Somerset,	Boston	3.50–4.00	5.50–6.50
Kanawha,	Columbus	5.25–6.25	7.00–8.50
Hocking,	Columbus	5.00–6.00	7.00–8.50
Pittsburgh No. 8	Cleveland	7.00–7.50	8.00–9.00
Franklin, Ill.,	Chicago	.....	.....
Central, Ill.,	Chicago	.....	.....
Ind. 4th Vein,	Chicago	.....	.....
West Ky.,	Louisville	10–10.50	7.00–7.50
Big Seam,	Birmingham	2.20–2.50	4.00–5.00
S. E. Ky.,	Louisville	9.00–9.50	7.00–8.50

FUEL OIL

New York—Aug. 3, Port Arthur light oil 22@25 deg. Baumé 4c. per gal.; 30@35 deg., 5c. per gal. f.o.b. Bayonne, N. J.

Chicago—July 26, for 24@26 deg. Baumé, $1.15 per bbl.; 21@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Aug. 1, f.o.b. refinery, Pennsylvania, 36@40 deg., 5c.@5½c.; Kentucky fuel oil, 26@30 deg., 3¾c.@4c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3¼c. Western, 24@30 deg., $1.05@$1.10 per bbl.

Philadelphia—July 31, 26@28 deg. Baumé, Oklahoma, 90c.@95c. per bbl.; 30@34 deg., Oklahoma (group 3), 2¼c. @2½c. per gal.; 16@20 deg. Seaboard, $1.35@$1.50 per bbl.

Cincinnati—Aug. 3, for 26@30 deg. Baumé, 5½c.; Diesel, 32@34 deg., 5¾c. per gal.; distillate 40@46 deg., 6¼c.

Cleveland—Aug. 3, 26@30 deg. Baumé, 4½c. per gal.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances—Structural shapes and cold finished steel advanced 15c. per 100 lb. in New York warehouses. Fire hose, 2½-in. coupled, up 2½c. per ft. Recent advance in hides reflected in slight rise in prices of leather belting and lacing. Linseed oil up 1c. in New York, 5c. in Chicago and 8c. per gal. (5 bbl. lots) in Cleveland, during the last month. Babbitt metal prices tending upward. Conduit, elbows and couplings, 2 per cent higher, f.o.b. New York.

Declines—No. 14 solid, two-conduit, armored cable down $1 per M. ft. Reduction of 40c. per M. ft. in rubber-covered, solid copper wire.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled	49½c. per ft.
Common, 2½-in., 3-ply	1.00 per ft. list less 50%

Air	First Grade	Second Grade
¾-in., 3-ply, per ft.	$0.31	$0.22½

Steam—Discounts from List

First grade	Second grade	Third grade
40–10%	50–5%	50–10–5%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	Best grade
60–10–5%	60–5%

LEATHER BELTING—List price per ply, 12-in. wide, per lin. ft. $2.88

Grade	Discount from list
Medium	40–5%
Heavy	30–5%

RAWHIDE LACING—For cut, best grade, 50–5%, 2nd grade, 55–5%. For laces in sides, best, 45c. per sq.ft.; 2nd, 43c. Semi-tanned: cut, 45–5%; sides, 47c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.80
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		60% off
For low-pressure heating and return lines	4-ply	70% off
	3-ply	72% off
	2-ply	74% off

PORTLAND CEMENT—New York, $2.40@$2.50 per bbl. without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $2.83 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	7.50@10.00	12.00	11.25
Mixed	5.50@ 9.00	9.00	8.00

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13½ x 13½	13½ x 20½
Cleveland	10.00	11.00
Chicago	10.00	13.00
New York	7.50	8.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.91	$1.15	$1.01

WHITE AND RED LEAD—Base price per pound:

	Red—Current		Red—1 Year Ago		White—Current	White—1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12.50	14.00	13.00	14.50	12.50	13.00
25- and 50-lb. keg	12.75	14.25	13.25	14.75	12.75	13.25
12½-lb. keg	13.00	14.50	13.50	15.00	13.00	13.50
5-lb. cans	15.50	17.00	16.00	17.50	15.50	16.00
1-lb. cans	17.50	19.00	18.00	19.50	17.50	18.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	60–5%	70%	60–10%
Tinned	60–5%	70%	4½c. per lb. net

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York	Chicago	Pittsburgh
$3.60	$3.10	$2.40

Boiler rivets, same sizes:

New York	Chicago	Pittsburgh
$3.70	$3.20	$2.50

REFRACTORIES—Prices in carlots:

Chrome brick, eastern shipping points	net ton	$42@45
Chrome cement, 40@45% Cr_2O_3	net ton	27@30
Chrome cement, 40@45% Cr_2O_3, in sacks	net ton	29.50@31.50
Magnesite brick: 9-in. shapes	net ton	56@58
Magnesite brick: 9-in. arches, wedges and keys	net ton	61.60@63.80
Magnesite brick: Soaps and spits	per ton	78.40@81.20
Silica brick: Chicago district	per 1,000	38@41
Silica brick: Birmingham, Ala.	per 1,000	42.00
Silica brick: Mt. Union, Pa.	per 1,000	33@35
Chrome ore crude, 45@50%	net ton	20@22
Magnesite dead burn (Imported)	net ton	30@33
Clay brick, 1st quality, 9-in. shapes, Missouri	per 1000	40@45
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per 1000	33@36
Clay brick, 1st quality, 9 in. shapes, Ohio	per 1000	33@36
Clay brick, 1st quality, 9 in. shapes, Kentucky	per 1000	33@36
Clay brick, 2nd quality, 9-in. shapes, Missouri	per 1000	30@35
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per 1,000	29@33
Clay brick, 2nd quality, 9 in. shapes, Ohio	per 1,000	29@33
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per 1,000	29@33

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
Fair grade	24.50	42.00	36.00
Commercial	11.12½	16.00	9.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting and screw stock, per 100 lb. base	$3.50	$3.40	$3.30
Flats, square and hexagons, per 100 lb. base	4.00	3.90	3.80

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	60%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	71	58½	¼ to 1½	44½	29½

LAP WELD

2	64	51½	2	39½	25½
2½ to 6	68	55½	2½ to 4	42½	29½
7 to 8	65	51½	4½ to 6	42½	29½
9 and 12	64	50½	7 to 12	40½	27½

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	69	57½	¼ to 1½	44½	30½
2 to 3	70	58½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	62	50½	2	40½	27½
2½ to 4	66	54½	2½ to 4	43½	31½
4½ to 6	65	53½	4½ to 6	42½	30½
7 to 8	61	47½	7 to 8	35½	23½
9 to 12	55	41½	9 to 12	30½	18½

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.15
1¼	.....	.....	.1650
1½	.....	.....	.1411
1¾	$0.1654	$0.1881	.1530
2	.1305	.1607	.1332
2¼	.1491	.1836	.1521
2½	.1566	.2160	.1824
2¾	.....	.....	.....
3	.1916	.2668	.2097
3¼	.2066	.3078	.2253
3½	.2204	.3282	.2403
4	.2800	.4173	.3054

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2¾ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3¼ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 40.00 (net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	35%	10%
Coils to 1,000 ft.	40%	20%
1,000 to 5,000 ft.	45%	22%
5,000 ft. and over	45–5%	25%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

Size, In.	Conduit Black	Conduit Galvanized	Elbows Black	Elbows Galvanized	Couplings Black	Couplings Galvanized
¼	$47.51	$52.76	$9.84	$11.18	$4.84	$5.27
⅜	60.76	67.79	12.95	14.48	6.91	7.52
½	86.35	96.75	13.05	21.44	8.98	9.78
¾	116.83	130.90	25.61	28.36	12.62	13.66
1	139.68	156.51	34.14	37.82	15.59	16.88
1¼	187.94	210.58	62.60	68.42	20.78	22.50
1½	297.15	332.95	102.44	113.46	29.70	32.15
2	388.58	435.40	273.19	302.57	44.55	48.22
2½	495.47	551.77	603.30	668.18	59.40	64.30
3	609.26	675.97	697.22	772.19	74.25	80.37

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.08	D. P. D. B.	$0.26
D. P. M. L.	.13	T. P. S. B.	.25
T. P. M. L.	.19	T. P. D. B.	.38
D. P. S. B.	.15		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.38	$1.20	$1.25
T. P. M. L.	.53	1.40	1 80
D. P. S. B.	.47	1.20	.....
T. P. S. B.	.88	2.00	.....
D. P. D. B.	.85	2.35	.....
T. P. D. B.	1.50	4.00	.....
T. P. to D. P. D. B.	1.00	2.75	.. ..

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$19.95
No. 16 cotton reinforced heavy	26.15
No. 18 cotton reinforced light	17.33
No. 16 cotton reinforced light	21.50
No. 18 cotton Canvasite cord	14.70
No. 16 cotton Canvasite cord	17.06

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$.20	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	0 30	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	2.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	3.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	5.60	225-amp. to 400-amp.,	25	5.50
425-amp. to 600-amp.,	10	.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 60–5%; standard package, 65–5%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$2.40
0-30 ampere, less than standard package	2.75

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.40	100	75	$0.70	$0.75	50
15	.35	.40	100	100	.95	1.00	24
25	.35	.40	100	150	1.30	1.40	24
40	.35	.40	100	200	1.80	1.90	24
50	.35	.40	100	300	2.50	2.65	24
60	.40	.45	100				12
				500	3.75	3.95	12
				750	5.25	5.50	8
				1.000	6.00	6.35	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.17
Composition 2-piece attachment plug	.26
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.56	$ 8.00	$10.02	$15.96
12	8.72	10.60	12.54	20.84
10	11.44	13.65	15.96	27.09
8	15.38	17.90	21.05	36.22
6	.....	.....	31.81	.....
4	.....	.....	42.94	.....
2	.....	.....	64.99	.....
1	.....	.....	86.83	.....
0	.....	.....	107.78	.....
00	.....	.....	127.89	.....
000	.....	.....	153.66	.....
0000	.....	.....	183.70	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	15%
1-5th to standard package	30%
Standard package	45%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	21c. lb.
Soldering paste, 2 oz. cans	$1.00 doz

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2 70	4.50	6.76	9.00
	TYPE "C" FUSIBLE, TOP OR BOTTOM			
30	70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $25.00 list value	25%
$25 to $50 list value	30%
$50 list value or over	35%

New Plant Construction

PROPOSED WORK

Cal., Delhi—The Delhi Land Colony will receive bids in about two months for one 8 sec. ft., one 4 sec. ft. 30 ft. lifts, and one 6 sec. ft., 40 ft. lift, Booster, double suction centrifugal pumps. E. Portier, Engr.

Cal., Los Angeles—Miller Box Mfg. Co., 201 North Ave. 18, A. Miller, Purch. Agt. is in the market for 5 and 10 hp. motors.

Cal., Oakland — The State, G. B. McDougall, State Archt., Forum Bldg., Sacramento is preparing plans for a 1 story women's shop building, 1 story recreation and 2 story employee's buildings and power house on 3601 Telegraph Ave.

Col., Denver—The U. S. Reclamation Service, A. P. Davis, Dir., will receive bids until Aug. 18 for furnishing radial gates and gate hoists, geared hoists, operating machinery, etc., for the Riverton project, Wyoming.

Fla., Quincy—The city, J. P. Smith, Clk., will receive bids until Aug. 24 for building 200,000 gal. reservoir and furnishing and installing the following equipment for water works and power plant improvements and water main extensions: Uniflow engine for direct connection to one 210 kva. 225 rpm. or 312 kva. 200 rpm. 120 lbs. steam pressure, one 210 kva. generator 225 rpm. or 312 kva. 200 rpm. 2 phase 60 cycle 2,300 volts for direct connection to above engines, one 3 panel switch board, 2 centrifugal pumps and motors 1,500 gal. per min. each 100 ft. head, one 500 hp. feed pump and heater, one motor driven air compressor 600 cu. ft., one condensor, one 200 hp. 125 lb. return tubular boiler, also 6,000 ft. of 6 and 8 in. pipe, gate valves, etc. J. B. McCrary Engineering Corp., Atlanta, Ga., Engrs.

Fla., Tampa—The Consumers Ice Co., C. Perry, Mgr., Polk and Marion Sts., will receive bids until Oct. 1 for 75 x 125 ft. ice manufacturing plant and machinery, 30 ton per day capacity. Estimated cost $20,000. Architect and Engineer not announced.

Ill., Peru—V. A. Matteson, Archt., 8 South Dearborn St., Chicago, is receiving bids for a 2 story, 150 x 185 ft. office building, including steam heating system, for the Western Clock Co., here. Estimated cost $250,000.

Ind., Connersville—The Hydro Electric Light & Power Co., plans to make improvements and extensions to plant and to various lines. Estimated cost $200,000. Engineer not announced.

Ia., Rockwell City—The city is having plans prepared for waterworks improvements, including reservoir, 200,000 gal. capacity and pumping machinery. Estimated cost $15,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Engrs.

Mass., Somerville—The Bd. School Comrs., is having plans prepared for a 3 story junior high school in the Western section. Estimated cost $800,000. Ritchie, Parsons & Taylor, 15 Ashburton Pl., Boston, Archts.

Mich., Detroit—Bonnah & Chaffee, Archts., 528 Farwell Bldg., are receiving bids for a 10 story, 40 x 100 ft. office building including steam heat and mechanical equipment on Randolph St. and Cadillac Square. Owner's name withheld.

Mich., Detroit—A. Kahn, Archt., 1000 Marquette Bldg., will receive bids until Aug. 15 for 5 story, 60 x 441 ft. factory for making automobile parts, on Campau Ave., for the Studebaker Corp., Brush St. and Piquette Ave. Estimated cost $400,000.

Mich., Menominee—The Wisconsin Public Service Corp., J. P. Pulliam, Secy., is having plans prepared for improvements to reservoir dam on the Menominee River and construct tainter gates for additional flood capacity. Estimated cost $25,000. Mead & Seaston, State Journal Blk., Madison, Wis., Engrs.

Minn., Duluth—The Universal Portland Cement Co., 202 Wolvin St., plans to increase capacity of plant 7-40% to bring up to annual capacity of 2,500,000 bbls. of cement, improvements including 200 ft. kiln for burning raw material and installing a dust collecting apparatus and other equipment. Estimated cost $200,000. Work to be done by day labor.

Minn., Grasston—The Grasston Co-operative Creamery Co., G. O. Larson, is in the market for 20 or 25 hp. stationary boiler. (New or Used).

Mo., Kansas City—The city plans election in November to vote on $100,000-$150,000 bonds for improving hospital at Leeds Farm, including complete east wing of building and install hospital to care for drug addicts, ice refrigerating plants, modern laundry for men and women's buildings and build electrical plant.

Mo., Kansas City—The Knights of Columbus, Marquette Council No. 1698, 1121 Grand Ave., plans to build 137 x 150 ft. club house and hotel on Forest Ave. and Armour Blvd. Estimated cost $350,000 to $400,000. Architect not announced.

N. J., Hammonton—The Littlefield Ice & Coal Co., plans to rebuild ice plant recently destroyed by fire and is in the market for complete refrigeration machinery and equipment.

N. Y., Brooklyn—Brooklyn Edison Co., 360 Pearl St., is having preliminary plans prepared for a 12 story office building including steam heating system on Willoughby and Pearl St. Estimated cost $1,000,000. McKenzie, Voorhies & Gwelin, Engrs.

N. Y., Mayfield—The Bd. of Trustees is having surveys made for distribution system, pumping station, etc., including equipment, 2 plunger pumps driven by gas engines and possibly 3 stage centrifugal fire pumps, 50 hp. motors. Estimated cost $50,000. M. Vrooman, 10 North Main St., Gloversville, Engr.

N. Y., New York—The Bd. of Educ., Flatbush Ave. and Concord St., Brooklyn, will receive bids until Aug. 11 for installing heating, ventilating and temperature regulating apparatus, etc., in additions to and alterations in P. S. No. 58 on East 176 St. and Washington Ave., Borough of Bronx, and P. S. No. 72 on Maspeth Ave. and Hill St., Borough of Queens.

N. Y., New York—The Police Dept., J. A. Leach, Acting Police Comr., Bookkeeper's Office, Headquarters, 240 Centre St., will receive bids until Aug. 11 for furnishing all labor and materials required in the installation of a low pressure c.i., sectional, header type, steam boiler at repair shop, 205 Mulberry St.

N. Y., New York—The Transit Comn., G. McAneny, Chn., 49 Lafayette St., received bids for installation of drainage pumps, furnishing 2 single motors and motor driven centrifugal pumps and installing them with 2 other pumps in the completed 14th St. Eastern subway at one of the sumps in Borough of Manhattan and 2 sumps in the Borough of Brooklyn, together with suction and discharge piping and accessories, including the furnishing of all materials except 2 pumps, from the Federal Constr. & Rep. Co., 27 William St., $1,435, The Maintenance Co., 435 West 42d St., $1,610, Peerless Engr. Co., 71 8th Ave., $2,005, Wagner Engr. Co., 435 Pearl St., $2,088. Noted July 25.

N. Y., Rochester—The Burnett Printing Co., 27 South Water St., is in the market for 50 to 60 hp. horizontal tubular boiler. (New or Used).

N. Y., Rochester—A. D. Hill, 420 Plymouth Ave., is in the market for one 6, 8 or 10 hp. upright boiler.

N. C., Forest City—The Forest City Oil Mill, J. E. Lipscomb, Purch. Agt., is in the market for one 20, one 5 and five 7 hp. motors, 3 phase, 60 cycle 550 volt. (Used).

N. C., Pinetops—The city, W. E. Cobb, Clk., will soon award the contract for 10 mi. of 13,000 volt, 3 phase transmission line from here to Tarboro.

N. C., Raleigh—The Odd Fellows Lodge, Home Bldg., having plans prepared for a 10 story office building, including heating plant, on Hargett and Salisbury Sts. G. Lloyd Preacher & Co., Healy Bldg., Atlanta, Ga., Archts.

Ohio, Cleveland—The City Purch. Dept., City Hall, is in the market for a class Q mechanical stoker for a D. Connelly Co. boiler.

Ohio, Piqua—The city council, F. W. De Weese, Mayor, plans complete waterworks pumping plant, driving wells and mains. Estimated cost $350,000. Engineer not selected.

Pa., Johnstown—The Bd. Educ. is receiving bids on an 80 x 242 ft. and 110 x 115 ft. auditorium and gymnasium building and class room building, also boiler house. Estimated cost $650,000. J. E. Adams, Archt.

Pa., Oil City—The Citizens Light & Power Co. plans to expend $95,000 for extensions and improvements to lines and systems here.

Pa., Osgood—Du Roth Steel Truck & Car Wheel Co., 611 Keystone Bldg., Pittsburgh, plans to build a manufacturing plant here, consisting of various buildings. Estimated cost $1,500,000. C. E. Long, 1202 Peoples Bank Bldg., Pittsburgh, Engrs.

Pa., Phila.—The Chestnut St. Realty Co., c/o Ritter & Shay, Archts., North American Bldg., plans to build a 24 story, 72 x 230 ft. office building at 15th and Chestnut St. Estimated cost $5,000,000.

Pa., Phila.—The Corn Exchange Natl. Bank, 1510 Chestnut Ave., will soon receive bids for 6 story, 40 x 138 ft. addition to bank building. Estimated cost $1,500,000. A. H. Brokie, 254 South 15th St., Archt.

Pa., Phila.—C. Siegel, 47 East Larchwood St., is receiving bids for a 6 story, 160 x 385 ft. apartment house at 47th and Pine Sts., including vapor heating system, laundry and boiler house. Private plans.

Pa., Pittsburgh—The H. C. Frick Coke Co., Carnegie Bldg., will soon receive bids for mammoth rubberized belt 4 ft. wide, ¾ in. thick, weight about 350 ton, in twenty separate lengths, length over all about 9 mi. for carrying coal through 4 mi. tunnel, in mine.

Pa., Pittsburgh—The Salvation Army, 324 Diamond St., plans to build a 7 story, 60 x 75 x 120 ft. home on 2nd, Cherry Way and 3rd Ave. Estimated cost $500,000. Architect not selected.

Pa., Warren—The Warren Light & Power Co., A. Stack, Mgr., 219 Liberty St., plans the construction of 21 mi. 33,000 volt transmission line from here to Tidioute and will give service to the towns of Irvine, Garland, Youngsville and Pittsfield. Estimated cost $50,000. Noted May 16.

Pa., Wilkinsburg — The Wilkinsburg Plaza Hotel Corp. Co., c/o A. A. Rockoff, 323 South Ave., plans to build 9 story apartment hotel on Penn and Hays Sts. Estimated cost $800,000. Architect not selected.

Pa., Wilkes Barre—The Luzerne County Natl. Bank, 27 Public Sq., has purchased site on Public Sq. and plans to build 10 story bank and office building. Architect not announced.

S. C., Sumter—The Sumter Ice & Fuel Co., E. H. Moses, Mgr., plans to build a creamery and ice plant, and will receive preliminary correspondence regarding construction and machinery from contractors, architects and dealers. About $30,000 to $40,000. Architect not selected.

Tenn., Knoxville—The Duncan Machinery Co., Dempster Bldg., is in the market for one 5, one 7½, one 10, two 15, two 25, one 75 and one 100 hp. a. c. motors, all 3 phase, 60 cycle, 220 volt.

Tex., Austin—The city, W. L. Eyers, Comr., Water and Light Dept., plans to purchase and install a turbo generator, capacity 5,000 kw., for the local water and light plant.

Tex., Brady—The Mayhew Produce Co. is in the market for machinery and equipment for proposed cold storage and refrigerating plant.

Va., Hampton Roads—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has received bids for coal and ash handling equipment at U. S. Naval Base as follows: (1) work complete from Specialty Engr. Co., Allegheny and Newton Sts., Phila., Pa., $72,930 (150 days), A. Pope, 4722 15th St., N.W., Wash., D. C., $79,900 (100 days), D. E. McIntyre, 74 Broad St., Boston, Mass., $81,540 (125 days). Noted July 18.

Va., Hampton Roads—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has received bids for heating plant building at the U. S. Naval Base, here from American Bridge Co., Wilkins Bldg., Wash., D. C., $24,707 (150 days); Miller Engineering Corp., 1012 Water St., Norfolk, Va., $27,300 (120 days). Spec. 4629. Noted July 18.

Va., Petersburg—G. W. Koiner is at the head of a company now being organized that plans the construction of a 5 story, 150 x 200 ft. cold storage plant. Estimated cost $1,000,000. Architect not selected.

Wis., Elkhorn—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are making specifications and will soon receive bids for 250 kw. electrical generating unit, 12 electric motors and 1 vacuum pump, for Wisconsin Butter & Cheese Co., here. Noted Feb. 21.

Wis., Madison—The City, H. C. Buser, Clk., is receiving bids for pumping machinery for the new pump station in Monona Park, and also for sewage disposal machinery. E. E. Parker, Engr.

Wis., Milwaukee—The city has received bids for furnishing and erecting Riverside Pumping Station at foot of Chambers St., from the Worden-Allen Co., Port Washington Rd., $71,462, Wisconsin Bridge & Iron Co., North Milwaukee, $72,180, Wagner Archtl. Iron Wks., 763 North Water St., $72,996.

Wis., Pound—The Wisconsin Public Service Corp., 559 Marshall St., Milwaukee, is having plans prepared for 20 miles of high voltage transmission line from here to Menominee. Mead & Seastone, State Journal Blk., Madison, Engrs.

Wis., Spring Green—The city, A. Schlosser, Clk., will receive bids until Aug. 10 for constructing and equipping pumping station, also furnishing and laying 6 and 8 in. pipe with fittings and valves. Estimated cost $25,000. W. G. Kerchoffer, Dean-Karster Bldg., Madison, Engr.

Wis., Stevens Point—B. V. Martin, 1303 Main St., is in the market for wood working machinery and electric motors.

B. C., Nanaimo—The city, H. Hackwood, Clk., plans to purchase and install large electric pump at new bridge at No. 1 dam.

N. B., St. Johns—Nasgwak Paper Mills, Ltd., plans to build additions to its paper manufacturing plant and will install machinery and equipment to increase its daily capacity from 60 to 80 tons. Estimated cost $500,000. Private plans.

Que., Montreal—The McGill University plans to build a 5 story engineering building on University and Milton Sts. Estimated cost $500,000. F. G. Robb, 127 Stanley St., Archt.

CONTRACTS AWARDED

Ark., Little Rock—The city has awarded the contract for the City Hospital to the Stewart-McGehee Construction Co. Estimated cost $500,000.

Cal., Presidio (San Francisco P. O.)—J. A. Wetmore, Acting Superv. Archt., Treas. Dept., Wash., D. C., has awarded the contract for pump house, pumping equipment and completing fire protection system to the Engineering Structure Co., Call Bldg., San Francisco, $24,850 (150 days). Noted July 11.

Conn., New Britain—The Bd. of Educ., A. D. Meredith, Secy., State House, Hartford, has awarded the contract for 1 and 2 story Normal School and boiler house on Camp St. to Fitzpatrick & McArthur, Yonkers, N. Y., $553,518; heating and ventilating to M. J. Daly & Sons Co., 555 Bank St., Waterbury, $60,077. Noted July 18.

Conn., New Britain—The General Hospital, Grand St., has awarded the contract for a 4 and 5 story addition to hospital, including steam and ventilating systems, on Griswold and Hawkins Sts. to the Eastern Engineering & Construction Co., 945 Main St., Bridgeport. Estimated cost $350,000.

Ill., Chicago—The Bd. Educ., 650 Clark St., has awarded the contract for 3 story addition to high school on 47th St. and Union Ave., to Paschen Bros., 111 West Washington St. Estimated cost $3,000,000, Steam heating system will be installed. Noted May 16.

Ill., Chicago—H. J. Schlacks, Archt., 721 North Michigan St., has awarded the contract for 7 story 65 x 170 ft. furniture exhibition building, on 1338 South Michigan St., to the H. F. Friestedt Co., 327 South LaSalle St. Estimated cost $250,000. Steam heating system will be installed.

Ind., Fort Wayne—First & Hamilton National Bank has awarded the contract for 12 story 120 x 155 ft. bank building to M. Irmscher & Sons, 118 West Berry St. Estimated cost $900,000. Noted Jan. 10.

Mass., South Hadley—Mount Holyoke College has awarded the contract for 3 story dormitory on the campus to the Casper Ranger Construction Co., 20 Bond St., Holyoke. Estimated cost $450,000. Steam heating system will be installed.

Mich., Detroit—The Park Davis Co., 2951 Atwater St., has awarded the contract for a 75 x 100 ft. addition to power house on Gouin St. to F. H. Davis, 18388 Penobscot Bldg. Estimated cost $75,000. Equipment includes two 500 kw. units, one 300 kw. unit, one 140 kw. unit, and coal pockets with conveying equipment. Noted June 20.

Mich., Houghton—The Bd. of Educ. has awarded the contract for 3 story, 185 x 250 ft. high and grade school to J. J. Michels. $340,000. Steam heating system will be installed. Noted July 4.

Minn., Duluth—The Devonshire Apt. Co., 324 East 17th St., Minneapolis, Wis., has awarded the contract for a 3 story, 130 x 200 ft. apartment house at 14th Ave. east and 1st St., here, to Carlsted Bros., 542 Builders Exchange, Minnneapolis, $350,000. steam heating system will be installed.

Neb., Grand Island—The city has awarded the contracts for sewer and sewage disposal plant as follows: section 1, including Imhoff tank, sludge bed, valves, motors, pumps, etc., and section 4, lift station No. 2 to H. J. Peterson, 1119 South 35th St., Omaha, $65,845.50, who sublet contract to Ward & Weighton, 516 Davidson Bldg., Sioux City, Ia., section 2, to C. L. Hansen, Charles City, Ia., $131,274, section 3, Chambers Constr. Co., $41,180.50, section 5, Hansen & Willodson, Omaha, $35,717.90.

N. Y., Buffalo—The city has awarded the contract for filtration plant substructures, Contract No. 1 to the Thompson-Starrett Co., 49 Wall St., New York, $1,800,480. Noted July 25.

N. Y., Elmira—The Bd. Educ., I. Smith, Comr., has awarded the contract for junior high school on the south side, general contract to the Felton Construction Co., $374,926, vacuum cleaning equipment, plumbing, heating and ventilating to Ellet-Stempfle Co., 112 Lake St., $83,867. Noted July 18.

N. Y., New York—J. Goldstein, c/o Schwartz & Gross, Archts. and Engrs., 347 5th Ave., will build a 9 story, 50 x 100 ft. hotel on 23 West 64th St. Work will be done by separate contracts.

N. Y., New York—The Paterno & Son Contracting Co., 117 West 54th St., will build a 15 story, 80 x 122 ft. apartment building, including steam heating system on 88th St. and Riverside Drive. Estimated cost $1,000,000. G. Angello, c/o owner, Engr. and Archt.

N. Y., New York—The Reconstruction Hospital, 395 Central Park West, has awarded the contract for a 12 story, 105 x 125 ft. hospital on 100th St. and Central Park West to C. T. Wills, Inc., 286 5th Ave. Estimated cost $1,000,000. Noted April 19, 1921.

N. Y., New York—Saks & Co., Broadway and 33rd St., has awarded the contract for 9 story store building on 5th Ave. and 50th St. to Cauldwell Wingate Co., 381 4th Ave, Estimated cost $2,000,000. Noted June 27.

N. Y., New York—J. Tischman & Son, 280 Madison Ave., will build 14 story apartment building, including steam heating system, on 87th St. and Park Ave. Estimated cost $1,500,000. Schwartz & Gross, 347 5th Ave., Archts. and Engrs.

Ohio, Ada—The Ohio Northern University has awarded the contract for 46 x 76 ft. power and heating plant to the O. M. Green Co., Citizens Bldg., Lima, $16,000. B. & W. Co. boilers will be installed. Noted July 4.

Ohio, Cleveland—The city has awarded the contract for building foundations for Fairmount pumping station to the Hunkin Conkey Construction Co., Century Bldg., $231,819.

Ohio, Youngstown — The Pennsylvania Ohio Power & Light Co., 2521 East Boardman St., will build an 8,000 hp. substation at Market St. Extension.

Pa., Phila.—J. W. Vandergrift, Furlong, Camden County, N. J., has awarded the contract for a 2 story, 111 x 226 ft. garage and repair shop at 11th and Indiana Ave., here, to H. E. Baton, 1716 Sansom St., Phila. $200,000.

Pa., Pittsburgh—The Donahoe Co., Inc., 421 Smithfield St., will build 3 story, 30 x 110 x 100 x 120 ft. food store on Diamond St. W. E. Sanman, Empire Bldg., Archts. Estimated cost $350,000. Work will be done by separate contracts under supervision of the architect. Noted July 11.

Wis., Eau Claire—Dells Paper & Pulp Co., Dells Dam, has awarded the contract for a 1 story, 40 x 70 ft. power house to C. R. Meyer Sons Co., 50 State St., Oshkosh. About $70,000.

Wis., Blue Mounds—The city has awarded the contract for reservoir, laying water mains, furnishing and installing equipment for waterworks system to Ayen, Petersen & Rue, Main St., Mt. Horeb. Estimated $25,000. Noted May 9.

Wis., Milwaukee—The S. S. Cyril & Methody Congregation, 1110 Milwaukee Ave., has awarded the contract for a 46 x 50 ft. central heating plant, including boiler house to the Milwaukee General Constr. Co., 427 Mitchell St. Heating and boilers to the Downey Heating & Supply Co., 614 Clybourn St. Estimated cost $40,000. Noted July 18.

Wis., Union Grove.—The State Bd. of Control, Capital Bldg., Madison, has awarded the contract for a 50 x 95 power house at the State Home for Feeble Minded, to the Immel Construction Co., 1200 North Main St., Fond du Lac, $38,843.

Ont., Thessalon—The council has awarded the contract for dam and power house and pipe line to McNamara Bros., Cullis Blk., Sault Ste. Marie, turbine and equipment to W. Kennedy & Sons, Owen Sound. Estimated cost $35,000. Noted May 30.

Employment—Business Opportunities—Equipment

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SEARCHLIGHT SECTION

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